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THE NEW YORK SUBWAY AND THE FUTURE.

Last week the New York Subway was put to the test of regular operation, and the fact that from the first train started the service has proceeded without a hitch speaks volumes for the ability of the designers of the system and of its details, and the skill and care exercised in the execution of the project. Elsewhere we print the concluding article of a description of the more interesting features of the plant. While the completion of the Subway may well be hailed with joy as a relief from conditions which had grown almost intolerable, and as a victory of civic needs over the apathy toward existing evils that is one of the singular and unfortunate characteristics of American public life, yet one instinctively falls to wondering of the future, and of the measure of the traffic that must be dealt with in the next few years. Every generation of men has seen the initiation and completion of enterprises that seemed of permanent importance, and every generation has lived long enough to see the next tear down and rebuild. Who shall have the prescience to build for a hundred years? And would he not be deemed a hare-brained fool for his pains? "Posterity be damned" has been the watchword of the chiefs of action since time immemorial. It is only when the shortcomings of present things become quickly evident and are driven back upon their authors that a sense of irritating ineffectiveness is really awakened. The Subway will certainly be good for this year and next—can we say decades as well? The growth of a city is a mysterious thing, not to be foretold. Time after time growth starts off boldly in a certain direction only to meet checks apparently enforced by an unseen hand. The only thing that can be held as certain is that as a whole a city, like every other body, tends to move in the line of least resistance. In certain directions it cannot move—Chicago cannot build East nor San Francisco west. The barriers are not to be overcome. But what of New York? A city apparently cannot stop growing save under the stress of some dire calamity and even then only for a brief season.

New York, already the second largest city of the world, may some day push even London hard for supremacy. It has far more reason to grow than has London, being the natural trade outlet of all the country from the Rocky Mountains to the Atlantic. If America ever gets any considerable portion of the world's carrying trade New York will be its center. But Manhattan is an island long and narrow with no easy outlet save to the north. It is this very fact that has caused the conditions which the Subway will at least temporarily relieve. As the city grows so will the difficulties of transit. When a territory steadily tears down three-story buildings and erects twelve or twenty-story towers there is steadily trouble ahead. And New York is at present pushing the skyscrapers uptown at a truly prodigious rate, greater than ever before in its history. Now the effect of this movement on the rapid transit situation is two-fold: In the first place, it indicates an enormous increase in the bulk of traffic, for a modern building of the first rank implies an actual working population of one or two or more thousands, and a tributary population of five thousand or more—enough to people a flourishing suburban town. Second, it means that an increasing amount of very dense traffic must be handled toward the upper part of the city, where the island is widest. Meanwhile the tunnels and bridges to span the rivers will multiply in order to get room for this surplus population which cannot be housed on the island or to the northward on account of the enormously enhanced cost of living in these regions. As a city grows the pressure on the low-priced wage

earner grows all out of proportion to his wages. Therefore, we must look forward to a time when there will be very much heavier crosstown and uptown traffic during the rush hours than now exists. An office building center at, say, Broadway and Fifty-ninth Street, would put an entirely new aspect upon the rapid transit situation of the metropolis, and a condition of similar sort must be expected.

In the natural course of events lower New York is likely to become a city of warehouses and commercial offices, with immense steamship traffic along its flanks. As for the residential districts, it is not a rash prophecy to say that they will be for the most part eliminated from Manhattan. There will be hives of workers in particular localities and perhaps a final stand of colossal flats around the upper part of Central Park, but hardly more than that, so that the effect of growth will not only demand a much greater working force, but will compel it to house itself miles away. In the natural course of events, then, our new Subway will be gorged with traffic within comparatively few years, and relief when it comes will be in further subways adapted to deal with a crosstown distribution. Meanwhile, there will be acute distress from lack of freighting facilities along the axis of the island, which will have in the near future to be met by freight viaducts or subways in the general direction of the present passenger traffic. The present Subway has been skillfully planned, but the rapidity of the uptown movement has already introduced a new situation. The traffic across both rivers is what must be dealt with in the future—the closer linking of Long Island and suburban New Jersey with Manhattan. These crosswise lines of communication must ultimately be the important ones in Greater New York, since they reach the only easily available regions for increased population, and they must not only connect with the present axial lines, but must themselves have axial extensions. It is a curious situation, but one upon the whole not unfortunate, for it means opening new areas to the city and the new subway falls into line as a necessary part of the scheme. Whether it is hopelessly congested in five years or in twenty-five is really a matter of small moment, for the necessities of the case plainly indicate the initiation of new efforts in quite different directions in the near future.

ECONOMICS OF HIGH VOLTAGE TRANSMISSION.

We print elsewhere a brief article on this topic by Mr. Wallace, which, however, does not claim to be an exhaustive study of the subject, but merely the reduction to formal shape of the tentative calculations which must necessarily be made in the course of designing a plant to determine the desirable efficiency. It has long been understood that Kelvin's law, dealing as it does with only one of several economic factors, cannot of itself determine the most desirable value of the line loss. There have been numerous attempts to so broaden it as to include all the factors concerned, but they have not been widely used, and it is questionable whether they can be made generally useful. All line calculations with reference to economy, while fairly simple in principle, involve of necessity so many variables that they are determinate only when some of the important quantities are given assumed values which may or may not be correct by the time the line is built. An equation of which many terms are time-variables of a non-periodic character gives a result which is only true for the instantaneous values assigned the variables; that is, for the particular epoch of the calculation. The investment which is sought to be determined is relatively permanent and therefore the calculations can never apply rigidly to it. They may, however, afford a convenient method of tentative investigation, and used in this way can most certainly be of use to the engineer in his preliminary work. To realize their limitations is to acquire the power of using them for exactly what they are worth, and the formulas of Mr. Wallace are adapted to this critical purpose.

To begin with, the formulas are wisely intended to be somewhat less completely general than usual. The investigation starts with the distance and total output as data. These are the real physical data with which all transmission schemes must start. The capital charge per kilowatt at the generating plant is also a safe constant within the limits of the discussion. The value taken is rather high as such enterprises go, which tends to lessen the economic relative importance of the line. Moreover, the station costs are rather too low for ordinary conditions at so large an assumed investment. These are minor matters, however. The real trouble begins with the market price of power and with the cost of line conductor. The latter is taken at an average value from which it may vary twenty per cent. in either direction, the former at a figure that is for any place of extremely uncertain stability. The actual earnings of a plant are subject to so great variations as regards the price obtained per unit, that the only way in which they can be used in computing the line is to assume a set of values and make tentative computations from them to get a general line on the economics of the situation rather than any detailed information. This cautious tentative method is the specially valuable feature of Mr. Wallace's procedure. The case he is investigating is a 200-mile transmission of 10,000 kw developed at the present limit of feasible voltage, 60,000; and the computations are carried out for two load factors, respectively unity and 0.66. Obviously load factor is an exceedingly important consideration in such a case. The most cursory glance at the results shows that the plant must be forced near to unity load factor to stand any chance of paying at all. Indeed, with the data assumed it is very doubtful whether a proper allowance for up-keep and depreciation would permit showing a profit at any value of the load factor which could be considered plausible.

This is quite in accord with general experience in the economic consideration of so long a transmission of so moderate an amount of energy, saleable at so moderate a price as $50 per kw-year. It is worth noting that at the 60,000 volts assumed a point has already been reached where further increase makes relatively small change in costs. In fact, for voltages above this we are disposed to think that increased cost and maintenance of pole line will have to be seriously considered as adverse factors. It also appears from the computations that all the profit would be eaten up by the transmission expense at a voltage of about 17,400. Obviously, all chance of financial success would have disappeared long before so low a voltage was reached. These long transmissions require a first-class market at stiff prices to show anything like decent returns and must be operated at very high voltage even so. But their case is not so helpless as it might appear at first sight, since by proper organization and management the actual sales of power can be made to show the equivalent of a preposterously high load factor. As transmissions grow longer the opportunity of interlinking them improves, and when joined into an operative network a surprising amount of load can be taken on. No plant which does its own distributing takes on a very large proportion of twenty-four-hour power. Most of the load is for only 10 or 12 hours, and in cases where several plants feed a large system it is frequently possible to take aboard considerably more aggregate load than the component plants worked individually would be safe in assuming. The principle is a familiar one, but its application in this large work is very important. It raises the virtual load factor to a point where plants otherwise impracticable can be made to pay. Finally, it appears from Mr. Wallace's formulæ that in this particular instance the most economical line loss is very near to that which would be assigned by ordinary considerations of regulation—which is pretty generally the case, by the way, within the range of data generally brought into such a problem. Mr. Wallace's formulæ, while con-

taining no startling innovations, will often be found convenient in making the trial calculations for a new system and have the merit of being fairly simple to apply.

THE METRIC SYSTEM.

Elsewhere we print in the form of a book review a consideration of the various attacks on the metric system brought forth the past several years by the bill now before Congress, which renders the use of that system compulsory after the lapse of a certain time, in the various departments of the National Government. We desire here to acknowledge our indebtedness to the authors of the book which we have taken as a text, for their industry in compiling perhaps every word that has ever been uttered against the metric system, thus enabling those who so desire to estimate the actual strength of the anti-metric case. We wish, however, to disclaim having any thought that the work, at least in so far as the authors depart from the task of compilation and introduce their own crude ideas or arguments—couched frequently in intemperate and at times in illiterate language—is worthy of those whose opinions and interests it purports to champion. As we have repeatedly observed in these columns, the opponents in this country of the metric system, with the exception of a noisy coterie who have taken advantage of the occasion to secure personal notoriety, are men whose opinions deserve respectful consideration. These may be divided into three classes—the conservative by disposition or through attachment to the conditions of a past period in which their life work lay; those convinced that a system not admitting of division by halves and thirds is an unnatural one; and a large body of manufacturers who fear the effect on their business of a change to the metric system.

As to the first-mentioned class, while their opposition to the metric system may be misguided, the spirit of conservatism they represent is nevertheless a valuable factor even with respect to progress, tending to check changes that otherwise might proceed at rates not warranted by all existing conditions. The second class base their opposition on principles which the late Herbert Spencer considered bound up with the doctrine of evolution, and of such importance that he left a legacy to be used in warding off the danger of the metric system. As to the third and most influential class—the opposing manufacturers—their dissent is based upon what they undoubtedly consider to be sound business grounds. To quote from a previous editorial: "In these days of keen competition a profitable business implies a skillful adjustment with respect to numerous factors, and a favorable balance sheet is the question of the hour, not of the distant future. Opportunism is thus almost necessarily the guiding policy in manufacturing, and even though personally recognizing the intrinsic merits of the metric system, the manufacturer as such is apt to view its adoption only in the light of involving an expense without prospect of any immediate return, and as menacing a delicately balanced factory organization." It is to the classes enumerated above that we particularly commend the several articles on the metric system printed elsewhere, for we believe that the fairness with which the metric view is therein presented will meet with their appreciation, even should it not carry conviction.

Owing to a widely circulated and extraordinary statement to the effect that the metric system has proved a failure where adopted in Europe, and particularly in France and Germany, we have secured articles reciting the present status of the system in those two countries—one from M. Ch.-Ed. Guillaume, a distinguished French engineer connected with the International Bureau of Weights and Measures at Sevres; and the other from Mr. Gisbert Kapp, the well-known electrical engineer, who, after a long professional career in England, has made Germany his adopted country. Dr. Louis Bell, who needs no introduction to our readers, considers the question from the general standpoint, and Mr. Fred J. Miller, the leading machine-tool authority of this country and perhaps of the world, shows the fallacy of the assumption that the introduction of the metric system would seriously affect the manufacturing industry. It is unnecessary to comment at length upon these articles, which so ably set forth the case of the metric system. The facts, briefly stated, are that our weights and measures are ancient, but laborious and cumbersome. Hardly any adult not engaged in teaching them can state all correctly from memory. They are as inferior in simplicity and utility to the metric units as is the old English guinea-pound-shilling-penny-farthing currency system to the modern civilized American dollar-cent-mill decimal currency system. Commencing with France at the end of the eighteenth century, country after country has thrown over its old barbaric system or systems and has adopted by law the international metric system, while no country regrets the change. At this time no person can be said to have a broad education who does not know the meaning of metric units and measures, which bright schoolboys learn in half an hour. Germany, whose industrial development is of the order of magnitude of the United States, made the change from the old Teutonic units to the metric system, by law, in 1871, and it is a matter of common knowledge that the change was virtually effected within a month without an unduly great bother or expense. In a year after the change only a very small minority of the people had failed to adopt it. These facts are well within the memory of the older living German population. Is it possible, therefore, that Germany and Continental Europe have done that which America with all her adaptiveness, versatility, progressiveness and energy cannot do?

Strong pressure is being brought at the present time upon the British Empire to adopt the metric system compulsorily. A bill to that effect has passed through the House of Lords, and has also passed its first reading in the House of Commons. The bill has been supported by signed petitions from Trade Unions and Traders' Associations to the total number of one-third of a million persons, and by official petitions from cities and towns whose total population is nearly three millions. The Conference of British Chambers of Commerce has strongly pronounced in its favor, and the British Colonies are among the most ardent and active supporters of the bill. Unless action is soon taken by our Congress, the initiative will fall to Great Britain, and we shall then be placed in the position of being compelled by the force of circumstances to supinely follow where we might have led. Surely, the conclusion of all the facts in the history of the metric system is that sooner or later it must become universal. It took nearly one hundred and fifty years for Arabic arithmetic, based on our new familiar numerals, 1, 2, 3 . . . . . 8, 9, 0, to supplant the unscientific and cumbersome old Roman system of I, II, III, ... VIII, IX, X which preceded it, and which was in universal use for all accounts, statistics and general arithmetical purposes, during the middle ages. We now wonder what could have caused the delay. Nevertheless, the change was opposed by many people—for a long period by a great majority—more vehemently than the opposition to the metric system in a more enlightened age. Finally, it should not be forgotten that the fight against the metric system has been brought about by a bill which merely renders the system compulsory with Government departments after a suitable period of preparation; and the strength of the metric case is curiously admitted by its opponents when they openly maintain—not that such trial will result in revealing the defects of the system and thus finally lead to its supercession—but that if given this foothold it will quickly drive the sacrosanct English system from American soil.

October Meeting of American Institute of Electrical Engineers.

The regular monthly meeting of the American Institute of Electrical Engineers was held at the Chemists' Club, Friday evening, October 28.

At the meeting of the board of directors in the afternoon a resolution was adopted approving of the consolidation of the library of the Institute with the libraries of the American Institute of Mining Engineers and the American Society of Mechanical Engineers, and providing, upon the removal of the several libraries to appropriate quarters, for an annual appropriation of $4,000, the third of the sum of $12,000 required for the administration and maintenance of the consolidated libraries.

President Lieb announced the presentation to the Institute by the British Institution of Electrical Engineers of an oil painting representing Dr. William Gilbert, of Colchester, before Queen Elizabeth. He then called upon Mr. Charles F. Scott to make a statement concerning the present status of the Union Engineering Building project. Mr. Scott reported upon the progress of the work, which thus far has consisted in the selection and approval of architects' plans. He said that it is hoped soon to have these plans in fairly matured shape so that they may be presented to the general membership.

Two papers were presented at the meeting, one by Mr. James Dixon, entitled "The Telautograph," and the other by Mr. Frank F. Fowle on "The Transposition of Electrical Conductors."

The paper by Mr. Dixon describes a form of telautograph invented by Mr. George S. Tiffany. The instrument is based upon the variable current principle, the motions of the transmitter pencil being resolved into two components acting to vary the value of two line currents. A pencil is attached to two lever arms carrying contact rollers at their ends. These rollers bear against the surfaces of two current-carrying rheostats connected to a source of constant-potential, direct current. When the pencil is moved, as in writing, the positions of the rollers upon the rheostats are changed and thereby currents of varying strengths are sent into the line wires. At the receiver these currents pass through two vertically movable coils suspended in magnetic fields. The coils move according to the strength of the line currents received, and their motion is communicated to levers similar to those of the transmitter. On these levers is mounted a receiver pen which, by the motion of the coils, is caused to duplicate the motions of the sending pencil.

The paper describes the apparatus in detail and its commercial applications. One of its important uses has been found in the United States Coast Defence Service in sending directions from position finding stations to gun stations. In reply to a question Mr. Dixon said that the longest line now in operation consists of seven miles of submarine cable at the Portland (Me.) fortifications. He said that seven receivers could be operated from one transmitter and that four receivers may be operated in multiple. Mr. Townsend Wolcott said that the instruments of this type used in the army have given good satisfaction and that they have not been affected by the concussion of guns. Mr. Dixon said that in some trials aboard the battleship *Alabama* the instruments were subjected to extreme tests, which they withstood successfully.

The paper by Mr. Fowle considers the subject of the transposition of telephone conductors from the mathematical standpoint in the first section, and in the second section gives examples of transpositions. The equations, which are also plotted as curves, take into account electromagnetic and electrostatic induction, mutual and self-induction and capacity.

It is stated that half or quarter-mile sections of telephone lines, transposed in the center, are satisfactory for long-distance service. The existence of cable at each end of a line of any considerable length of aerial line will reduce the crosstalk. In the case of poles carrying many lines, 15 types of transposition are usually sufficient, these being enough, for example, for a 40-wire line. The paper gives illustrations of many types of transpositions and also treats the problem of transposition to counteract the effect of neighboring power lines.

In conclusion, Mr. Fowle suggested for the consideration of the Institute the recommendation of standards in the matter of wire separations, cross arms and systems of transposition. The adoption of such standards will greatly facilitate the removal of inductance interferences and materially assist the builders of telephone circuits throughout the country.

In the discussion of the paper Prof. Franklin took issue with Mr. Fowle concerning the derivation of some of his equations. In reply to a question as to the reason why cable ends on long telephone lines serve to reduce crosstalk, Mr. Fowle said that this is practically due to the effect of increased attenuation. The complete transposition of the cable itself practically eliminates all crosstalk which arises there and increased attenuation diminishes the effect of the crosstalk which may come in from other points. Mr. Mailloux said that he did not remember having ever before seen in so simple a form an equation like that which Mr. Fowle gives for the reactions of two magnetic fields upon each other; when examined it seemed to be the mathematical typification, so to speak, of the circle, which must be the case if magnetic lines are completely closed circuits. In reply to a question, Mr. Fowle said that in the case of a pole line carrying 2,000-volt wires 8 in. apart, if the telephone circuit is distant two or three feet, having also an 8-in. spacing, there would be no difficulty with transpositions every 10 poles or certainly not more than a quarter of a mile apart. Mr. Fowle, in answer to another question, said that telephone engineers have met with no difficulty whatever in obtaining perfect freedom from crosstalk with as many circuits on a pole line as it is possible for it to hold from this mechanical standpoint. With five or six cross arms the fifth arm can be transposed like the top arm, the sixth arm like the second arm, etc., with inducing transpositions perhaps every eight miles at the junction of two consecutive sections.

Architect's Plans of the Union Engineering Building.

At the monthly meeting last week of the American Institute of Electrical Engineers, Mr. Charles F. Scott, as one of the A. I. E. E. conferees, made a statement concerning the architectural design of the Union Engineering Building. The building will be situated on Thirty-ninth Street, midway between Fifth and Sixth Avenues, facing south. The entrance floor will have a large central corridor, with offices for administration and the like; in general it is to be a large assembling place for audiences coming in to find their way upstairs, and audiences upon being dismissed will not be crowded in a small corridor, but will have a large circulating place for leaving the building. There will be a carriage drive around the whole building, covered on one side. The building itself will be practically free and open on all sides. At the east side Mr. Carnegie has generously purchased a lot and put a building restriction on it, so that there will be no house on the lot higher than four stories. That will give light and air above to the east perpetually. On the west there is a ten-foot space left vacant, and on the rear there is a little space for the driveway at the back, so that, with the exception of a small area on one side, there will be air and light on all sides of the building. On the second floor there will be a large auditorium seating somewhere from 1,200 to 1,500 persons. The plan is to have ample corridors around the meeting room for the circulation of visitors and for those who want to talk, who can then step outside the meeting room and talk there. Above will be some smaller lecture halls. One of these will be in amphitheatre style, so that any experiments or demonstrations can be readily seen. There will be some smaller halls also, for smaller meetings, so that a large convention with several sections going at once, can easily be held, or several independent separate conventions.

The upper floor will be set aside for the various societies, for the use of secretaries, board rooms, etc. One or two rooms may be fitted up in club style, making a comfortable place to sit and talk, with a writing and reading room. There will be ample room for the other societies which desire quarters in the building. There are a number of general engineering societies in existence now which will undoubtedly desire quarters in the building, such as railway clubs, chemical societies, societies of gas engineers, societies of municipal engineers and the like. There are some dozen or more that were communicated with last year and they were found very cordial to the idea of their coming in and sharing the building. At the top there will be a large library and reading room, with overhead light and a stack room just below. At the suggestion of the general building committee, the several societies have appointed a general committee on library, the idea of bringing the libraries of the various societies together and making it the nucleus for a great engineering library. Details of the library scheme are given on this page, above.

Underground Rapid Transit in New York City.—III.

(Concluded.)

FIG. 1.—STATION PANEL AT ASTOR PLACE.

SINCE the first two sections of this article appeared, the Interborough Rapid Transit system has gone into full, smooth and successful operation, beginning with October 27, when 150,000 persons used the new facilities for swift travel from one end of the city to the other. One may be justified in noting the coincidence of this great event with the parallel celebration on October 28 of the one hundred and fiftieth anniversary of Columbia University and of the successful testing on the track, near Schenectady, of the first electric locomotive that is to operate on the lines of the New York Central Railroad. It was, indeed, a great week for Manhattan Island and the Empire State, as well as in its implications of what the future may hold in store. The "Subway" being started, however, it is now fitting to bring to a close our description of it, and we shall now supplement the data with regard to power house, sub-stations, generating plant and track, etc., by an account of the motors, rolling stock, signals and other important features.

THE CAR MOTORS.

The average speed of express trains between City Hall and One Hundred and Forty-fifth Street on the West Side will approximate 25 miles an hour, including stops. The maximum speed of trains will be 45 miles per hour. The average speed of local and express trains will exceed the speed made by the trains on any elevated railroad. To attain these speeds without exceeding maximum safe limiting speeds between stops, the equipment provided accelerates trains carrying maximum load at a rate of 1.25 miles per hour per second in starting from stations on level track. To obtain the same acceleration by locomotives, a drawbar pull of 55,000 pounds would be necessary—a pull equivalent to the maximum effect of eight steam locomotives such as were used recently upon the Manhattan Elevated Railway in New York, and practically equivalent to the pull which can be exerted by three passenger locomotives of the Pennsylvania Railroad type. Three of these latter would weigh nearly 400 net tons. By the use of the multiple-unit system of electrical control, equivalent results in respect to rate of acceleration and speed are attained, the total addition to train weight aggregating but 55 net tons. If the locomotive principle of train operation were adopted, therefore, it is obvious that it would be necessary to employ a lower rate of acceleration for express trains. This could be attained without very material sacrifice of average speed, since

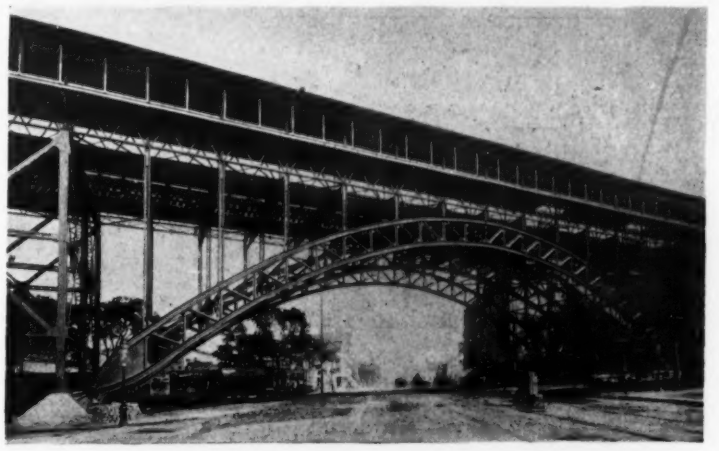


FIG. 3.—RAPID TRANSIT BRIDGE AT MANHATTAN VALLEY.

the average distance between express stations is nearly two miles. In the case of local trains, however, which average nearly three stops per mile, no considerable reduction in the acceleration is possible without a material reduction in average speed. The weight of a local train exceeds the weight of five trail cars, similarly loaded, by 33 net tons, and equivalent adhesion and acceleration would require locomotives having not less than 80 net tons effective upon drivers.

The multiple-unit system adopted possesses material advantages over a locomotive system in respect to switching at terminals. Some of the express trains in rush hours will comprise eight cars, but at certain times during the day and night, when the number of people requiring transportation is less than during the morning and evening, were locomotives used an enormous amount of switching, coupling and uncoupling would be involved by the comparative frequent changes of train lengths. In an eight-car multiple-unit express train,

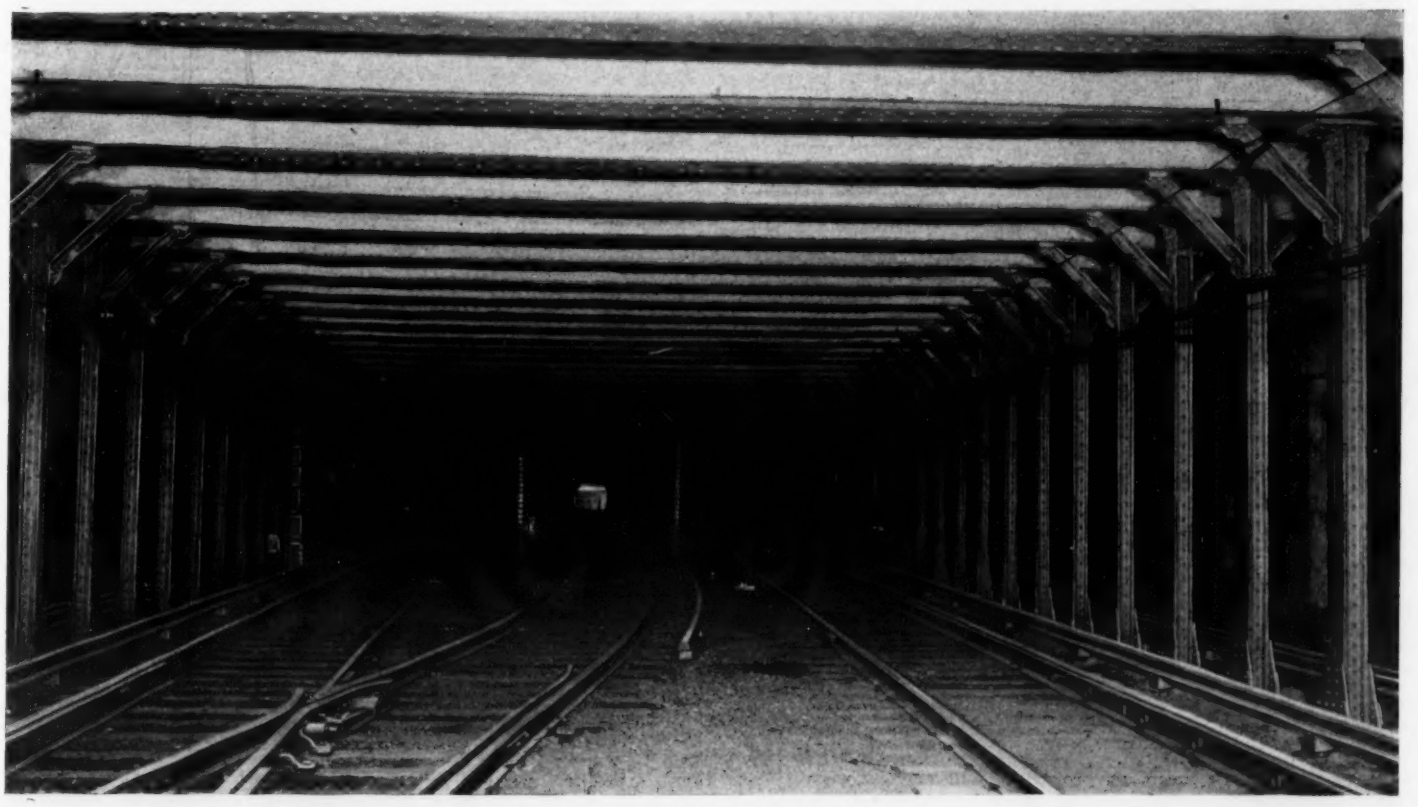


FIG. 2.—TYPICAL SECTION OF SUBWAY, SHOWING CENTRAL EXPRESS TRACK AND THIRD RAIL.

the first, third, fifth, sixth and eighth cars will be motor cars, while the second, fourth and seventh will be trail cars. An eight-car train can be reduced, therefore, to a six-car train by uncoupling two cars from either end, to a five-car train by uncoupling three cars from the rear end, or to a three-car train by uncoupling five cars from either end. In each case a motor car will remain at each end of the reduced train. In like manner, a five-car local train may be reduced to three cars, still leaving a motor car at each end, by uncoupling two cars from either end, since in the normal five-car local train the first, third and fifth cars will be motor cars.

FIG. 4.—SUBWAY MOTOR WITH CASE OPEN.

The motors are of the direct-current series type and are rated 200 hp each. They have been especially designed for the Subway service in line with specifications prepared by engineers of the Interborough Company, and will operate at an average effective potential of 570 volts. They were supplied by the General Electric and Westinghouse Companies and differ in respect to important features of design and construction. The weight of one make complete, with gear and gearcase, is 5,900 pounds. The corresponding weight of the other is 5,750 pounds. The ratio of gear reduction used with one motor is 19 to 63, and with the other motor 20 to 63.

By the system of motor control adopted for the trains, the power delivered to the various motors throughout the train is simultaneously controlled and regulated by the motorman at the head of the train. This is accomplished by means of a more or less familiar system of circuits comprising essentially a small drum controller and an organization of actuating circuits conveying small currents which energize electric magnets placed beneath the cars, and so open and close the main power circuits which supply energy to the motors. A controller is mounted upon the platform at each end of each motor car, and the entire train may be operated from any one of these points, the motorman normally taking his post on the front platform of the first car. The switches which open and close the power circuits through motors and rheostats are called contactors, each comprising a magnetic blow-out switch and the electromagnet which controls the movements of the switch. By these contactors the usual series-multiple control of direct-current motors is effected. The primary or control circuits regulate the movement, not only of the contactors, but also of the reverser, by means of which the direction of the current supplied to motors may be reversed at the will of the motorman.

CAR WIRING.

In wiring the cars unusual precautions have been adopted to guard against risk of fire. The floors of all motor cars are protected by sheet steel and a material composed of asbestos and silicate of soda, which possesses great heat-resisting properties. In addition to this, all of the important power wires beneath the car are placed in conduits of fire-proof material, of which asbestos is the principal constituent. Furthermore, the vulcanized rubber insulation of the wires themselves is covered with a special braid of asbestos, and in order to diminish the amount of combustible insulating material, the highest grade of vulcanized rubber has been used, and the thickness of the insulation correspondingly reduced. It is confidently believed that the woodwork of the car body proper cannot be seriously endangered by an accident to the electric apparatus beneath the car. The motors and car wiring are protected by a carefully planned system of fuses.

Express trains and local trains alike are provided with a bus line, which interconnects the supply of current to all cars and prevents interruption of the delivery of current to motors in case the collector shoes attached to any given car should momentarily fail to make contact with the third rail. At certain cross-overs this operates to prevent extinguishing the lamps in successive cars as the train passes from one track to another. The controller is so constructed that when the train is in motion the motorman is compelled to keep his hand upon it, otherwise the power is automatically cut off and the brakes are applied. This important safety device, which, in case a motorman be suddenly incapacitated at his post, will

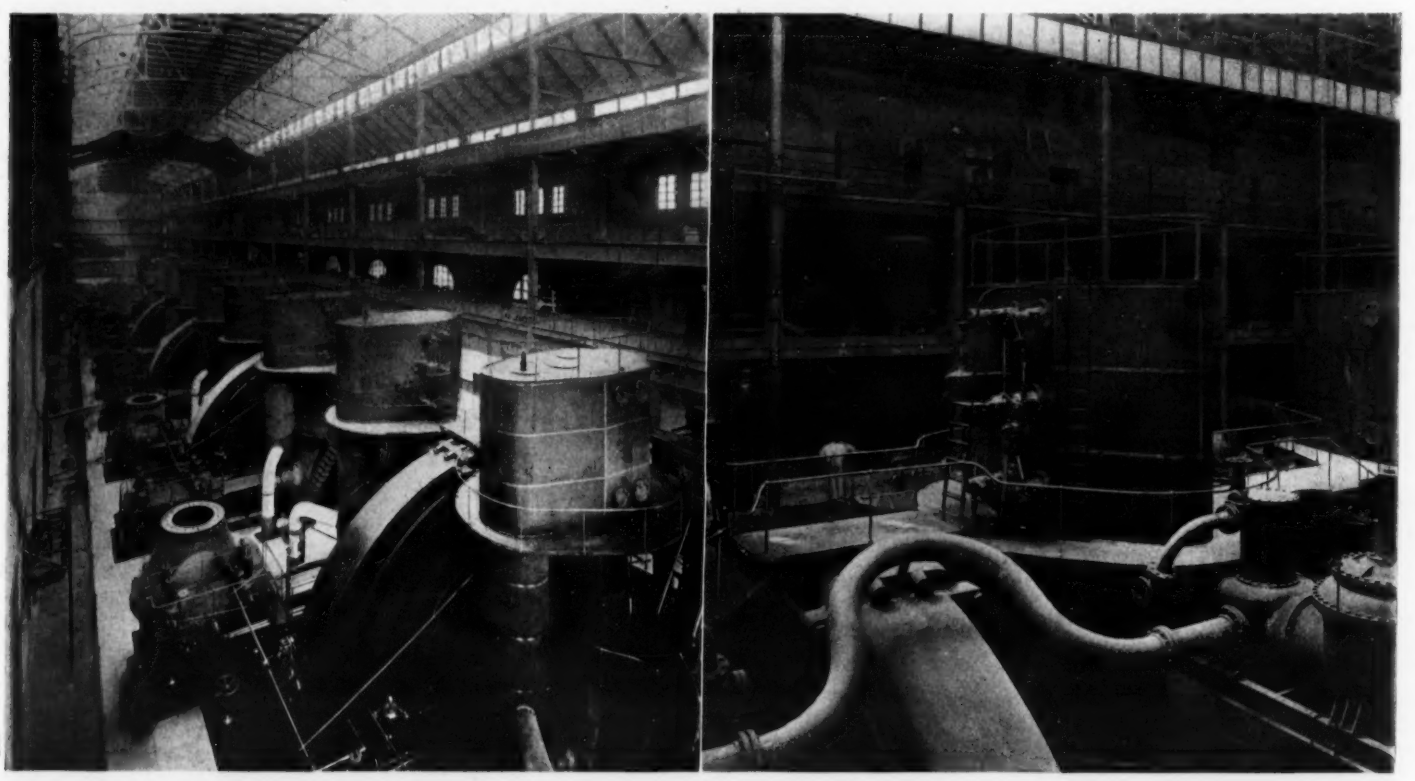


FIG. 5.—VIEWS OF THE GENERATING UNITS IN SUBWAY POWER HOUSE.

promptly stop the train, is a recent invention and is first introduced in practical service upon the trains of the Interborough Company.

All cars are heated and lighted by electricity. The Consolidated Car Heating Company heaters are, as usual, placed beneath the seats, and special precautions have been taken to insure uniform distribution of the heat. The wiring for heaters and lights has been practically safeguarded to avoid, so far as possible, all risk of short-circuit or fire, the wire used for the heater circuits being carried upon porcelain insulators from all woodwork by large clearances, while the wiring for lights is carried in metallic conduit. All lamp sockets are specially designed to prevent possibility of fire and are

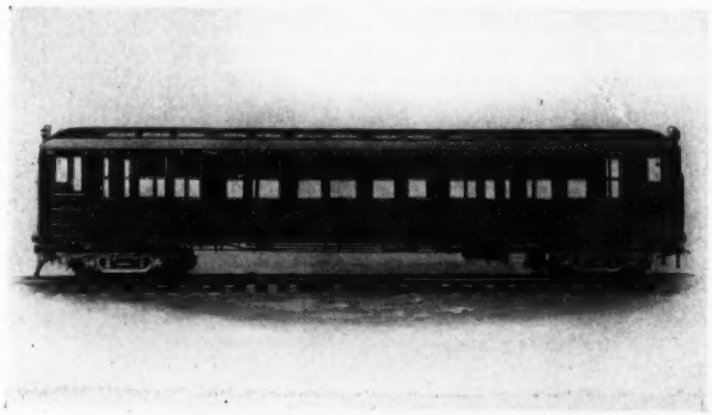


FIG. 6.—STEEL CAR, RAPID TRANSIT SYSTEM.

separated from the woodwork of the car by air spaces and by asbestos. The interior of each car is lighted by twenty-six 10-cp lamps, in addition to four lamps provided for platforms and markers. The lamps for lighting the interior are carefully located, with a view to securing uniform and effective illumination.

THE CARS.

On account of the special traffic conditions existing in New York City and the restricted siding and yard room available in the Subway, it was decided that one standard type of car for all classes of service

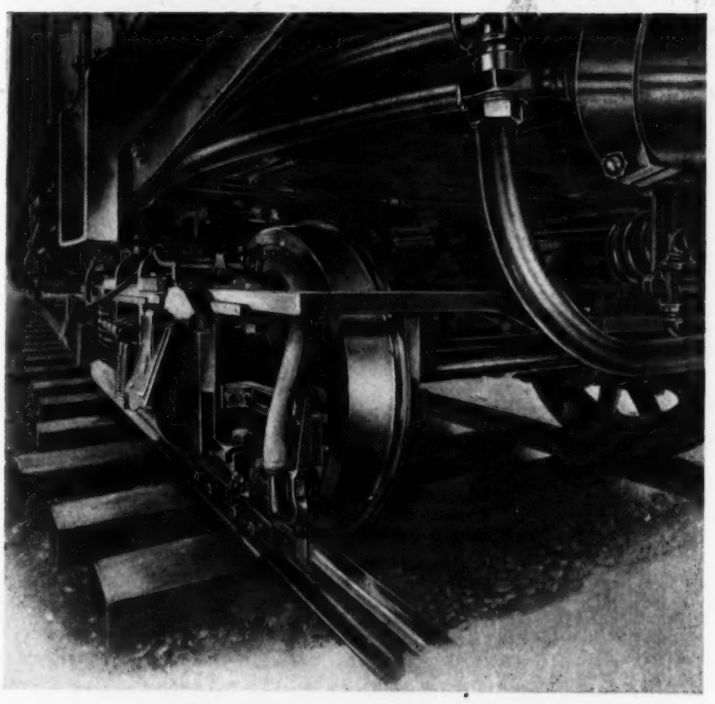


FIG. 7.—AIR BRAKE VALVE ON TRUCK, TO OPEN IF TRAIN OVERRUNS STOP.

would introduce the most flexible operating conditions, and for this reason would best suit the public demands at different seasons of the year and hours of the day. In order further to provide cars, each of which would be as safe as the others, it was essential that there should be no difference in constructional strength between the motor cars and the trail cars. All cars were, therefore, made of one type and can be used interchangeably for either motor or trail car service. The motor cars carry both motors on the same truck; that is, they have a motor truck at one end carrying two motors, one geared to each axle. The truck at the other end is a trailer and carries no motive power. The car length is 51 ft. and the seating capacity is 52 passengers, while it is needless to add that there is a liberal provision of straps. He is a rare New Yorker who would not rather stand than "wait for the next car." The platforms have vestibule platforms with sliding doors instead of the usual collapsible gates. The steel underframing provides a rigid and durable bed structure for transmitting the heavy motive power stresses.

The precautions to secure safety from fire consist generally, as already noted, in the arrangement and installation of the electrical apparatus and the wiring. For the lighting circuits a flexible steel conduit is used, and a special junction box. On the side and upper roofs, over these conduits for the lighting circuits, a strip of sheet iron is securely nailed to the roof boards before the canvas is applied. The wires under the floor are carried in ducts moulded into suitable forms of asbestos compound. Special precautions have been taken with the insulation of the wires, the specifications calling for, first, a layer of paper, next a layer of rubber, and then a layer of cotton saturated with a weather-proof compound, and outside of this a layer of asbestos. The hangers supporting the rheostats under the car body are insulated with wooden blocks, treated by a special process, being dried out in an oven and then soaked in an insulating compound, and covered with ¼-in. "transite" board. The

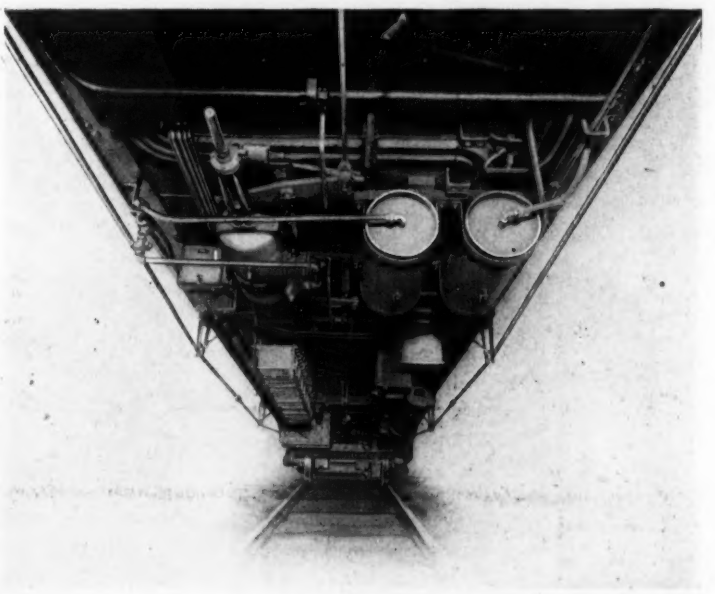


FIG. 8.—UNDERSIDE OF RAPID TRANSIT MOTOR CAR.

rheostat boxes themselves are also insulated from the angle-iron supporting them. Where the wires pass through the flooring they are hermetically sealed to prevent the admission of dust and dirt.

At the forward end of what is known as the No. 1 end of the car all the wires are carried to a slate switchboard in the motorman's cab. This board is 44 x 27 in., and is mounted directly back of the motorman. The window space occupied by this board is ceiled up and the space back of the panels is boxed in and provided with a door of steel plate, forming a box, the cover, top, bottom and sides of which are lined with electrobestos ½ in. thick. All of the switches and fuses, except the main trolley fuse and bus line fuse, which are encased and placed under the car, are carried on this switchboard. Where the wires are carried through the floor or any partition, a steel chute, lined with electrobestos, is used to protect the wires against mechanical injury. It will be noted from the above that no power wiring, switches or fuses are placed in the car itself, all such devices being outside in a special steel insulated compartment.

A novel feature in the construction of these cars is the motorman's compartment and vestibule, which differs essentially from that used heretofore, and the patents are owned by the Interborough Company. The cab is located on the platform, so that no space within the car is required; at the same time the entire platform space is available for ingress and egress, except that on the front platform of the first car, on which the passengers would not be allowed in any case. The side of the cab is formed by a door, which can be placed in three positions. When in its mid-position it encloses a part of the platform, and this would be its position on the rear platform of the rear car. The third position is when it is swung

around to an arc of 180°, when it can be locked in position against the corner vestibule post enclosing the master controller. This would be in its position on all platforms except on the front of the front car or the rear of the rear car of the train.

The car windows have two sashes, the lower one being stationary, while the upper one is a drop sash. This arrangement reverses the ordinary practice, and is desirable in Subway operation and to insure safety and comfort to the passengers. The side windows in the body of the car, also the end windows and end doors, are provided with roll shades with pinch-handle fixtures.

In addition to the "wooden" cars there are already in use the first installment of 200 "all steel" cars, of the same general dimensions. The flooring is of galvanized, corrugated sheet iron, laid across the longitudinal sills and secured to longitudinal angles by rivets. This corrugated sheet holds the fire-proof cement flooring called "monolith." On top of this latter are attached longitudinal floor strips for a wearing surface. The platform flooring is of steel plate covered with rubber matting cemented to the same. The side and end frame is composed of single and compound posts made of steel angles or T's and the roof framing of wrought-iron carlines and purlines. The sides of the cars are double and composed of steel plates on the outside, riveted to the side posts and belt rails, and lined with electrobestos. The outside roof is of fire-proof composite board, covered with canvas. The headlinings are of fire-proof composite, faced with aluminum sheets. The mouldings throughout are of aluminum. The wainscoting is of "transite" board and aluminum, and the end finish and window panels are of aluminum lined with asbestos felt. The seat frames are of steel throughout, as are also the cushion frames. The sash is double, the lower part being stationary and the upper part movable. The doors are of mahogany, and are of the sliding type and are operated by the trucks door operating device already described.

Two types of trucks are built, one for the motor end, the other for the trailer end of the car. The following are the principal dimensions of the trucks:

	Motor Truck.	Trailer Truck.
Gauge of track	4 ft. 8½ ins.	4 ft. 8½ ins.
Distance between backs of wheel flanges	4 ft. 5⅜ ins.	4 ft. 5⅜ ins.
Height of truck center-plate above rail, car body loaded with 15,000 pounds	30 ins.	30 ins.
Height of truck side-bearings above rail, car body loaded	34 ins.	34 ins.
Wheel base of truck	6 ft. 8 ins.	5 ft. 6 ins.
Weight on center plate with car body loaded, about	27,000 lbs.	
Side frames, wrought-iron forged	2½ ins. x 4 ins.	1½ ins. x 3 ins.
Truck bolster	cast steel	Wood and iron
Spring plank, wrought-iron	1 in. x 3 ins.	
Bolster springs, elliptic, length	30 ins.	White oak
Equalizing springs, double coil, outside dimensions	4⅞ ins. x 7½ ins.	32 ins.
Wheels, cast steel spoke-center, steel-tired, diam.	33¾ ins.	3⅝ ins. x 6 ins.
Tires, tread M. C. B. Standard	2⅝ ins. x 5¼ ins.	30 ins.
Axles, diameter at center	6½ ins.	2⅝ ins. x 5¼ ins.
Axles, diameter at gear-seat	7 13-16 ins.	
Axles, diameter at wheel-seat	7¾ ins.	4¾ ins.
Journals	5 ins. x 9 ins.	5¾ ins.

Both the motor and the trailer trucks have been designed with the greatest care for severe service, and their details are the outcome of years of practical experience.

THE SIGNAL SYSTEM.

A most elaborate and carefully thought-out signaling and block system has been applied to the Subway, a leading idea being the use of the "overlap" distance as in England, the length of the "overlap" being given most serious consideration and test. A diagram is shown in Fig. 15 of the manner in which this overlapping block signal system is worked out, and illustrative of the possible position of trains running under its application. It may be noted that the length of the overlap section was determined by the local conditions at each point. In order to provide for adverse conditions, the actual braking distance was increased by 50 per cent.; for example, the braking distance of a train moving 35 miles an hour is 465 ft.; this would be increased 50 per cent. and the overlap made not less than 697 ft. With this length of overlap the home signals could be located 697 ft. apart, and the block section length would be double this, or 1,394 ft. The average length of overlaps, as laid out, is about 800 ft., and the length of block sections double this, or 1,600 ft.

The block signaling system as installed consists of the automatic overlapping system applied to the two express tracks between City Hall and Ninety-sixth Street, a distance of six and one-half miles, or thirteen miles of track; and to the third track between Ninety-sixth and One Hundred and Forty-fifth Streets on the West Side branch, a distance of two and one-half miles. This third track is placed between the two local tracks, and will be used for express traffic in both directions, trains moving toward the City Hall in the morning and in the opposite direction at night; also the two tracks from One Hundred and Forty-fifth Street to Dyckman Street, a distance of two and one-half miles, or five miles of track. The total length of track protected by signals is twenty-four and one-half miles.

The small amount of available space in the Subway made it necessary to design a special form of the signal itself. Clearances would not permit of a "position" signal indication, and, further, a position signal purely was not suitable for the lighting conditions of the Subway. A color signal was, therefore, adopted conforming to the adopted rules of the American Railway Association. It consists of an iron case fitted with two white lenses, the upper being the home signal and the lower the distant. Suitable colored glasses are mounted in slides which are operated by pneumatic cylinders placed in the base of the case. Home and dwarf signals show a red light for the danger or "stop" indication. Distant signals show a yellow light for the "caution" indication. All signals show a green light for the "proceed" or clear position. Signals in the Subway are constantly lighted by two electric lights placed back of each white lens, so that the lighting will be at all times reliable. On the elevated structure, semaphore signals of the usual type are used. The signal lighting is supplied by a special alternating-current circuit independent of the power and general lighting circuits.

A train stop or automatic stop of the Kinsman system, invented by Mr. F. E. Kinsman, is used at all block signals, and at many interlocking signals. This is a device for automatically applying the air brakes to the train if it should pass a signal in the stop position. This is an additional safeguard only to be brought into

FIG. 9.—INSTRUMENT CASE IN ADVANCE OF THE BLOCK SIGNAL.

FIG. 10.—FEEDER SWITCHES TO CONTACT RAIL.

FIG. 11.—TYPICAL BLOCK SIGNAL IN THE SUBWAY.

action when the danger indication has for any reason been disregarded, and insures the maintenance of the minimum distance between trains as provided by the overlaps established. Great care has been given to the design, construction and installation of the signal apparatus, so as to insure reliability of operation under the most adverse cónditions, and to provide for accessibility to all the parts for convenience in maintenance. The system for furnishing power to operate and control the signals consists of the following:

Two 500-volt, alternating-current feed mains run the entire length of the signal system. These mains are fed by seven direct-current, motor-driven alternating generators in multiple, located in the various sub-power stations. Any four of these machines are sufficient to supply the necessary alternating current for operating the system. Across these alternating mains are connected the primary coils of track transformers located at each signal, the secondaries of which supply current of about 10 volts to the rails of the track sections. Across the rails at the opposite end of the section is connected the track relay, the moving element of which operates a contact. This contact controls a local direct-current circuit operating, by compressed air, the signal and automatic train stop.

Direct current is furnished by two mains extending the length of the system, which are fed by eight sets of 16-volt storage batteries

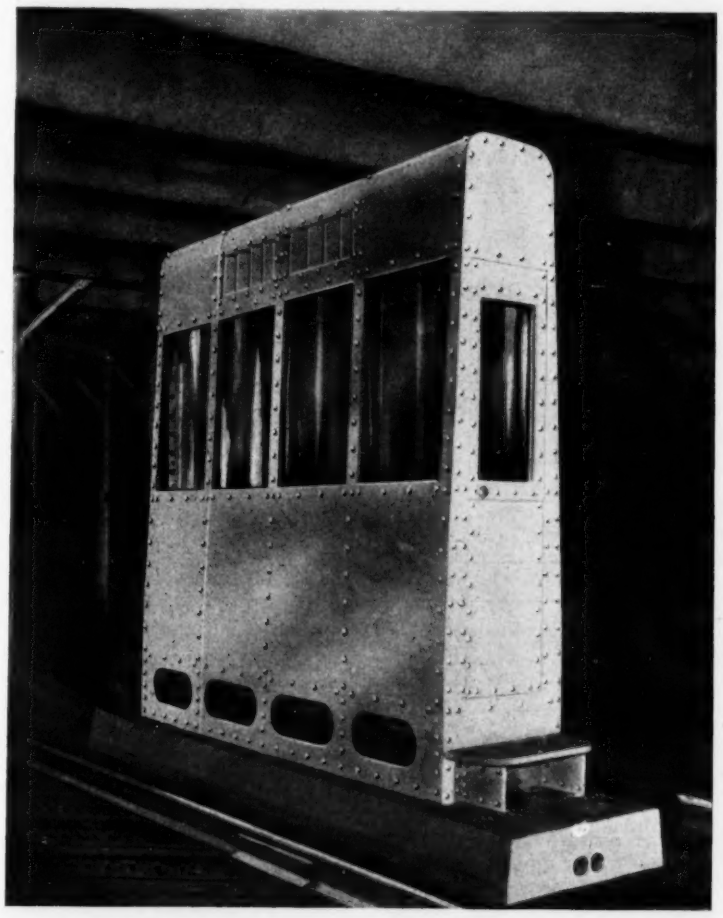


FIG. 12.—SPECIAL INTERLOCKING SIGNAL CABIN SOUTH OF BROOKLYN BRIDGE STATION.

in duplicate. These batteries are located in the Subway at the various interlocking towers, and are charged by motor-generators, one of which is placed at each set of batteries. These motor-generators are driven by direct current from the third rail and deliver direct current of 25 volts.

The compressed air is supplied by six air compressors, one located at each of six sub-stations. Three of these are reserve compressors. They are motor-driven by direct-current Westinghouse motors, taking current from the direct-current bus-bars at sub-stations at from 400 to 700 volts. The capacity of each compressor is 230 cu. ft.

The motor-driven air compressors are controlled by a governor, which responds to a variation of air pressure of five pounds or less. When the pressure has reached a predetermined point the machine is stopped and the supply of cooling water shut off. When the pressure has fallen a given amount, the machine is started light, and when at full speed the load is thrown on and the cooling water circulation re-established. Oiling of cylinders and bearings is automatic, being supplied only while the machines are running.

Two novel safety devices having to do especially with the signaling may be here described. The first is an emergency train stop. It is designed to place in the hands of station attendants, or others, the emergency control of signals. The protection afforded is similar in principle to the emergency brake handle found in all passenger cars, but operates to warn all trains of an extraneous danger condition. It has been shown in electric railroading that an accident

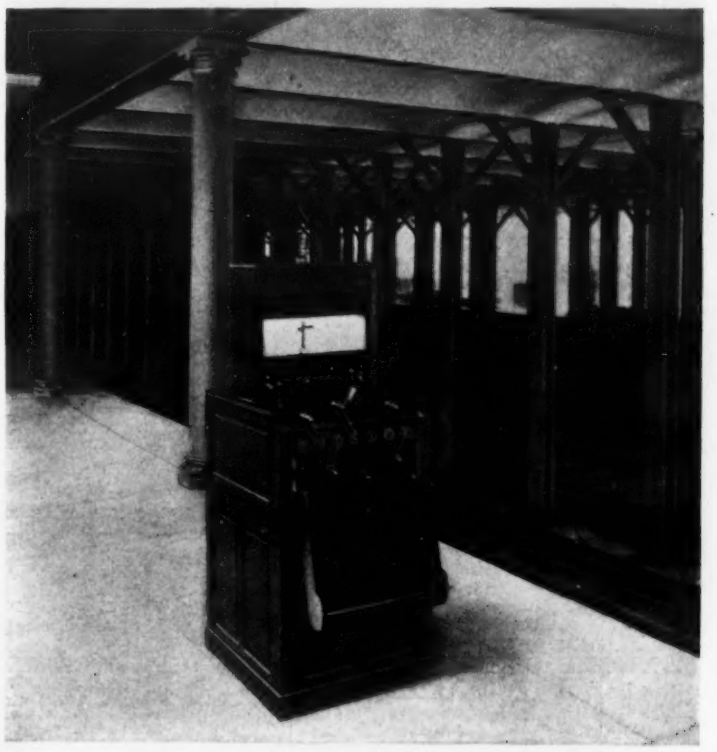


FIG. 13.—ELECTRO-PNEUMATIC INTERLOCKING MACHINE ON STATION PLATFORM.

to apparatus, perhaps of slight moment, may cause an unreasoning panic, on account of which passengers may wander on adjoining tracks in front of approaching trains. To provide as perfectly as practicable for such conditions, it has been arranged to loop the control of signals into an emergency box set in a conspicuous position in each station platform. The pushing of a button on this box, similar to that of the fire alarm signal, will set all signals immediately adjacent to stations in the face of trains approaching, so that all traffic may be stopped until the danger condition is removed.

FIG. 14.—MECHANISM FOR PNEUMATIC TRACK TRAIN STOP.

The second safety appliance is the "section break" protection. This consists of a special emergency signal placed in advance of each separate section of the third rail; that is, at points where trains move

from a section fed by one sub-station to that fed by another. Under such conditions the contact shoes of the train temporarily span the break in the third rail. In case of a serious overload or ground on one section, the train wiring would momentarily act as a feeder for the section, and thus possibly blow the train fuses and cause delay. In order, therefore, to prevent trains passing into a dangerously overloaded section, an overload relay has been installed at each section break to set a "stop" signal in the face of an approaching train, which holds the train until the abnormal condition is removed. The whole signal and interlocking system, inclusive of some details not here referred to, was installed by the Union Switch & Signal Company. It may be noted that at City Hall no fewer than three separate plants are required, all of considerable size.

STATION LIGHTING, ETC.

The engineers of the Interborough Company realized at the very outset the importance of maintaining lights in the Subway independent of any temporary interruption of the power used for lighting the cars, and, in preparing their plans, they provided for lighting the Subway throughout its length from a source independent of the main power supply. For this purpose three 1,250-kw alternators direct-driven by steam turbines are installed in the power house, from which point a system of primary cables, transformers and secondary conductors convey current to the incandescent lamps used solely to light the Subway. The alternators are Westinghouse three-phase, 1,250-r.p.m., 60-cycle, at a potential of 11,000 volts. In the boiler plant and system of steam piping installed in connection with these turbine-driven units, provision is made for separation of the steam supply from the general supply for the 5,000-kw units and for furnishing the steam for the turbine units through either of two alternative lines of pipe. The 11,000-volt primary current is conveyed through paper-insulated, lead-sheathed cables to transformers, located in fire-proof compartments adjacent to the platforms of the passenger stations. These transformers deliver current to two separate systems of secondary wiring, one of which is supplied at a potential of 120 volts and the other at 600 volts.

The general lighting of the passenger station platforms is effected by incandescent lamps supplied from the 120-volt secondary wiring circuits, while the lighting of the Subway sections between adjacent stations is accomplished by incandescent lamps connected in series groups of five each and connected to the 600-volt lighting circuits. Recognizing the fact that in view of the precautions taken it is probable that interruptions of the alternating-current lighting service will be infrequent, the possibility of such interruption is nevertheless provided for by installing upon the stairways leading to passenger station platforms, at the ticket booths and over the tracks in front of the platforms, a number of lamps which are connected to the contact rail circuit. This will provide light sufficient to enable passengers to see stairways and the edges of the station platforms in case of temporary failure of the general lighting system.

The general illumination of the passenger stations is effected by means of 32-cp incandescent lamps, placed in recessed domes in the ceiling. These are reinforced by 14-cp and 32-cp lamps, carried by brackets of ornate design where the construction of the station does not conveniently permit the use of ceiling lights. The lamps are enclosed in sand-blasted glass globes, and excellent distribution is secured by the use of reflectors.

In lighting the Subway between passenger stations it is desirable, on the one hand, to provide sufficient light for track inspection and to permit employes passing along the Subway to see their way clearly and avoid obstructions; but, on the other hand, the lighting must not be so brilliant as to interfere with easy sight and recognition of the red, yellow and green signal lamps of the block signal system. It is necessary also that the lights for general illumination be so placed that their rays shall not fall directly upon the eyes of approaching motormen at the head of trains nor annoy passengers who may be reading their papers inside the cars. The conditions imposed by these considerations are met in the four-track sections of the Subway by placing a row of incandescent lamps between the north-bound local and express tracks and a similar row between the south-bound local and express tracks. The lamps are carried upon brackets supported upon the iron columns of the Subway structure, successive lamps in each row being 60 ft. apart. They are located a few inches above the tops of the car windows and with reference to the direction of approaching trains the lamps in each row are carried upon the far side of the iron columns, by which expedient the eyes of the approaching motormen are sufficiently protected against their direct rays.

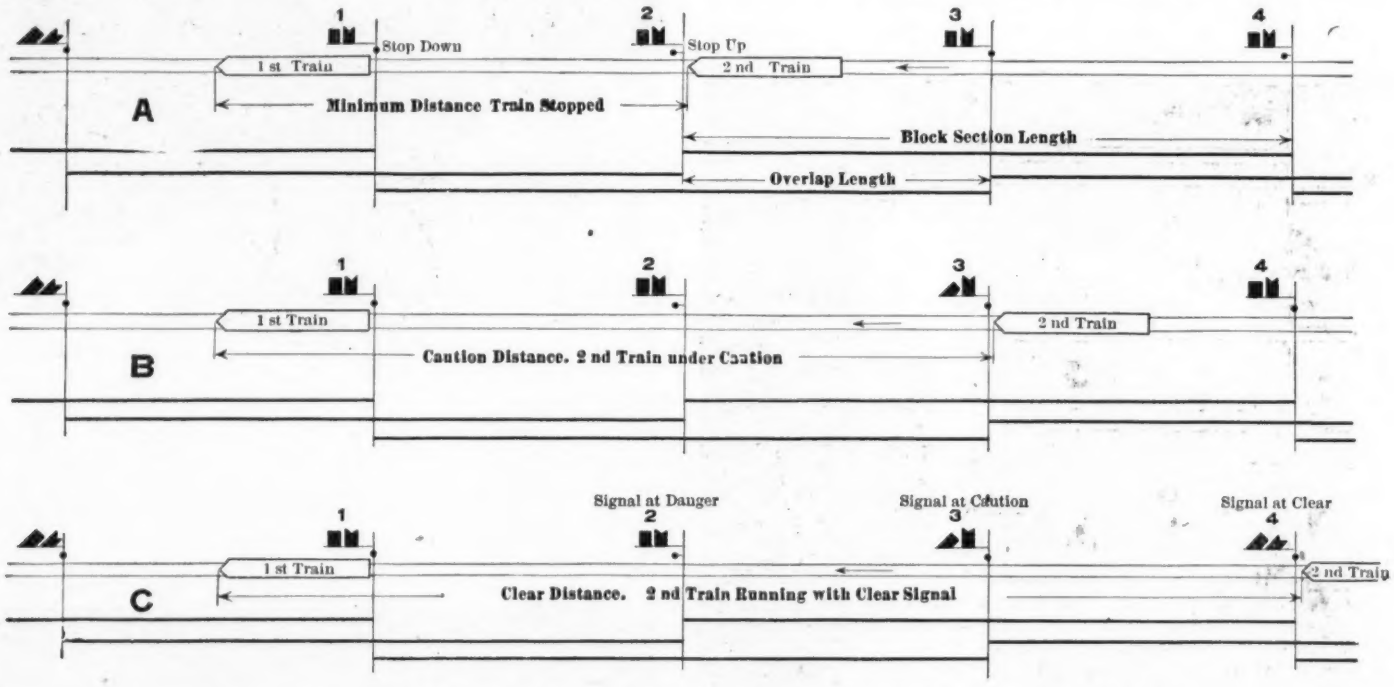


FIG. 15.—POSSIBLE POSITION OF TRAINS UNDER THE APPLICATION OF SUBWAY SIGNAL SYSTEM.

In the booth of each ticket seller and at every manhole along the west side of the Subway and its branches is placed a glass-covered box of the kind generally used in large American cities for fire alarm purposes. In case of accident in the Subway which may render it desirable to cut off power from the contact rails, this result can be accomplished by breaking the glass front of the emergency box and pulling the hook provided. Special emergency circuits are so arranged that pulling the hook will instantly open all the circuit-breakers at adjacent sub-stations through which the contact rails in the section affected receive their supply of power. It will also instantly report the location of the trouble, annunciator gongs being located in the sub-stations from which power is supplied to the section, in the train dispatcher's offices and in the office of the general superintendent, instantly intimating the number of the box which has been pulled. Automatic recording devices in train dispatcher's offices and in the office of the general superintendent also note the number of the box pulled.

An interesting innovation is the use of electric heat in the passenger stations, for which purpose a number of the metallic "mica strip"

heaters of the Prometheus Electric Heating Company of a special model have been installed.

MISCELLANEOUS LIGHTING, ETC.

In the general illumination of the engine room of the great power house described in Part I of this article, clusters of Nernst lamps are used, supported from the roof trusses, and a row of single lamps of the same type is carried on the lower gallery about 25 ft. from the floor. This is the first power house in America to be illuminated by these lamps. The quality of the light is unsurpassed and the general effect of the illumination most satisfactory and agreeable to the eye. In addition to the Nernst lamps, 16-cp incandescent lamps are placed upon the engines and along the galleries in places not conveniently reached by the general illumination. The basement also is lighted by incandescent lamps.

For the boiler room a row of Nernst lamps in front of the batteries of boilers is provided, and, in addition to these, incandescent lamps are used in the passageways around the boilers, at gauges and at water columns. The basement of the boiler room, the pump room, the economizer floor, coal bunkers and coal conveyors are lighted by incandescent lamps, while arc lamps are used around the coal tower and dock. The lights on the engines and those at gauge

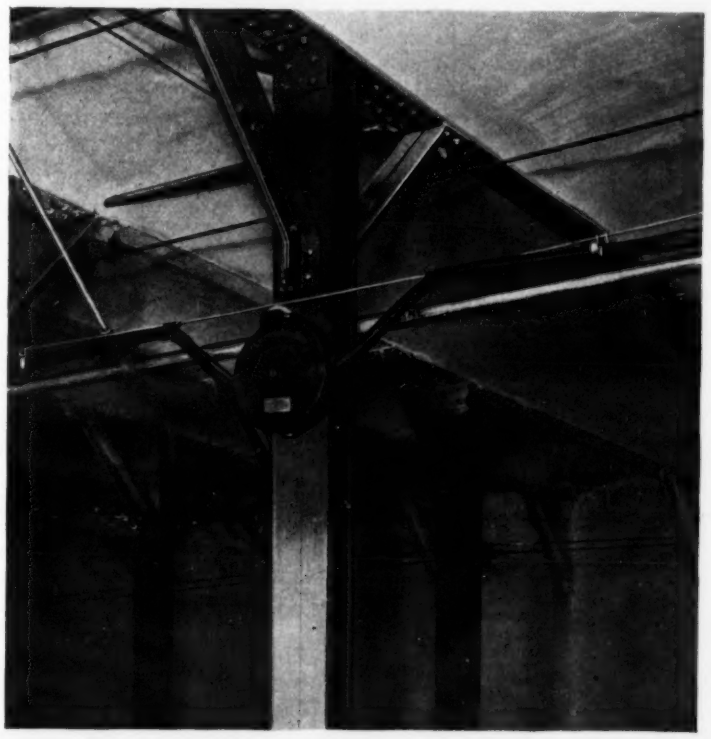


FIG. 16.—AIR SUPPLY PIPING AND CONDUIT SYSTEM IN TUNNEL.

glasses and water columns and at the pumps are supplied by direct current from the 250-volt circuits. All other incandescent lamps and the Nernst lamps are supplied through transformers from the 60-cycle lighting system.

REPAIR AND INSPECTION SHOPS.

The repair and inspection shop of the Interborough Rapid Transit Company adjoins the car yards of the company and occupies the entire block between Seventh Avenue on the west, Lenox Avenue and the Harlem River on the east, One Hundred and Forty-eighth Street on the south, and One Hundred and Forty-ninth Street on the north. The electric Subway trains will enter the shops and car yard by means of the Lenox Avenue extension of the Interborough Rapid Transit Railway. This extension runs directly north from the junction at One Hundred and Forty-second Street and Lenox Avenue of the East Side main line of the company. The branch leaves the main line at One Hundred and Forty-second Street, gradually approaches the surface, and emerges at about One Hundred and Forty-seventh Street. The inspection shed is at the southern end of the property and occupies an area of approximately 336 ft. x 240 ft. It is divided into three bays, of which the north bay is equipped with four tracks running its entire length, and the middle bay with five tracks. The south bay contains the machine tool equipment, and consists of eighteen electrically-driven machines, locker and washrooms, heating boilers, etc., and has only one track extending through it.

The construction of the inspection shops is that which is ordinarily known as "reinforced concrete," and no wood is employed in the walls or roof. The building is a steel structure made up of four rows of center columns, which consist of twenty-one bays of 16 ft. each, supporting the roof trusses. The foundations for these center columns are concrete piers mounted on piles. After the erection of the steel skeleton, the sides of the building and the in-

FIG. 17.—AN ENTRANCE TO THE SUBWAY.

terior walls are constructed by the use of ¾-in. furring channels, located 16 in. apart, on which are fastened a series of expanded metal laths. The concrete is then applied to these laths in six coats, three on each side, and termed respectively the scratch coat, the rough coat and the fining coat. In the latter the concrete is made with white sand, to give a finished appearance to the building.

The third rail is not carried into the shops, but the cars will be moved about by means of a special trolley. In the middle bay this trolley consists of a four-wheeled light frame carriage, which will be run on a conductor located in the pit. The carriage has attached

FIG. 18.—CITY HALL STATION.

to it a flexible wire, which can be connected to the shoe hanger of the truck or to the end plug of the car, so that the cars can be moved around in the shops by means of their own motors. In the north bay, where the pits are very shallow, the conductor is carried overhead and consists of an 8-pound T-rail supported from the roof girders.

The middle bay is provided with a 50-ton electric crane, which spans all of the tracks in this shop and is so arranged that it can serve any one of the thirty cars on the five tracks, and can deliver the trucks, wheels, motors and other repair parts at either end of

the shops, where they can be transferred to the telpherage hoist to be described later.

One of the most interesting features of the shops is the electric telpherage system, which runs the entire length of the north and south bays, crossing the middle bay or erection shop at each end, so that the telpherage hoist can pick up in the main room any wheels, trucks or other apparatus which may be required, and can take them either into the north bay for painting, or into the south bay or machine shop for machine tool work. The telpherage system extends across the transfer table pit at the west end of the shops and into the storehouse and blacksmith shop at the Seventh Avenue end of the grounds, to be described later.

The traveling telpher hoist has a capacity of 6,000 pounds. The girders upon which it runs consist of 12-in. I-beams, which are hung from the roof trusses. The car has a weight of one ton and is supported by and runs on the I-beam girders by means of four 9-in. diameter wheels, one on each side. The hoist is equipped with two motors. The driving motor of two horse-power is geared by double reduction gearing to the driving wheels at one end of the hoist. The hoist motor is of eight horse-power, and is connected by worm gearing and then by triple reduction gearing to the hoist drum. The motors are controlled by rheostatic controllers, one for each motor. The hoist motor is also fitted with an electric brake by which, when the power is cut off, a band brake is applied to the hoisting drum. There is also an automatic cut-out, consisting of a lever operated by a nut, which travels on the threaded extension of the hoisting drum shaft, and by which the current on the motor is cut off and the brake applied if the chain hook is wound up too close to the hoist.

The buildings are heated throughout with steam on the Warren-Webster principle, with vacuum system of return. The steam is supplied by two 100-hp return tubular boilers, located at the south-eastern corner of the building and provided with a 28-in. stack 60 ft. high. The heat is distributed at 15 pounds pressure throughout the three bays by means of coil radiators, which are placed vertically against the side walls of the shop and storeroom. In addition, heating pipes are carried through the pits as already described. The shops are well lighted by large windows and skylights, and at night by enclosed arc lights.

The general storeroom, oilroom and blacksmith shop occupy a building 199 ft. x 22 ft. in the southwestern corner of the property. This building is of the same general construction as that of the inspection shops. The general storeroom, which is that fronting on One Hundred and Forty-eighth Street, is below the street grade, so that supplies can be loaded directly onto the telpherage hoist at the time of their receipt, and can be carried to any part of the works, or transferred to the proper compartments in the storeroom. Adjoining the general room is the oil and paint storeroom, which is separated from the rest of the building by fire walls. This room is fitted with a set of eight tanks, each with a capacity of 200 gallons. As the barrels filled with oil and other combustible material are brought into this room by the telpherage system they are deposited on elevated platforms, from which their contents can be tapped directly into the tank. The final division of the west shops is that in the northeastern corner, which is devoted to a blacksmith shop. This shop contains six down-draft forges and one drop hammer, and is also served by the telpherage system.

Connecting the main shops with the storeroom and blacksmith or west shops is a rotary transfer table 46 ft. 16 13/16 in. long and with a run of 219 ft. The transfer table is driven by a large electric motor, the current being supplied through a conductor rail and sliding contact shoe. The transfer table runs on two tracks and is mounted on 33-in. standard car wheels.

The British Pacific Cable.

It is stated that the all-British Pacific cable has not given the financial results that were expected, and that Canada's share in the deficit on the first year's operation amounted to $120,000. A conference of the partners in the cable is to meet in London, the chief object of which is to ascertain by what means this annual deficit may be overcome, and, if possible, to bring about an annulment of the concessions made by New South Wales to the Eastern Extension Cable Company. This company is a direct competitor with the Government-owned British cable to Australia and its agreement with the New South Wales Government gives it advantages which most seriously prejudice the business prospects of the British cable.

Electric Light and Power in South America.

BY VICTOR M. ARANA.

FEW are aware of the rapid progress made in the introduction of electric power in South America. If we have in mind the many difficulties and obstacles which modern improvements and inventions meet in conservative countries, this gives indeed an eloquent proof of the wonderful adaptability of electric power to all manner of requirements and conditions. The latest electric labor-saving devices and power appliances are now being introduced in regions where the use of mechanical power in any form was hardly known, and where even the time-honored steam engine was a rare luxury.

Ten years ago there was not an electric railway system, few of the capital cities boasted of electric lighting plants, and the use of electricity for industrial purposes was not dreamed of. Now, however, a veritable transformation is taking place in the southern continent. Every town of some importance wishes to be up-to-date; importers, contractors and engineers have more than they can do introducing and installing electric railway, lighting and power plants.

There have been two foremost causes that have delayed the bringing about of this state of affairs: the unstable condition of governments and the high price of coal. With the first no extensive industries could be established, due to the fear entertained by capitalists and business men lest their interests would serve, now and then, as campaign resources and war funds for the contending factions. The enormous cost of coal, which could be obtained only from English ports, made the use of steam for factories almost prohibitive, and even in very profitable industries other kinds of fuel were used, in spite of their poor quality and the inconveniences consequent to their use.

Now, however, one obstacle has been remedied and the other avoided. The "Big Four" among South American nations, Argentina, Brazil, Peru and Chile, have done away with revolutions and similar political upheavals. Military governments are a thing of the past in those countries; capable and energetic men are at the heads of the governments, and large investments in various industrial enterprises and commercial schemes are the result of the beneficial change. On the other hand, the recent phenomenal success attained in electrical long-distance transmission of power, in this country and Europe, has practically obviated the difficulties due to the lack of coal; for already large industrial plants have been established and more are in project, using water power.

Undoubtedly, the general adoption of electric power in South America is primarily due to the exceptional adaptability of that continent to the generation of hydro-electric power. About three-fourths of South America is composed of deep valleys, high plateaus and chains of mountains. This peculiar configuration of the territory, which is everywhere lined with streams, varying in size from gigantic rivers of the Amazonic type, to shallow six-month streams, affords innumerable waterfalls, some of which could certainly rival Niagara in volume of water and the Californian mountain streams in abruptness of fall. The Andes Mountains, which cross South America from Panama to Chile, with their branches and highlands surrounded by them, form a mammoth continental reservoir, whose storage capacity and multitudinous outlets are well-nigh beyond ordinary calculation. The facility with which these waterfalls can be harnessed and the growing demand for power in those new communities point to an era of water power developments very similar to the one which took place on the Pacific Coast and those in Southern France and Mexico. If to this we add the unusual facilities afforded by governments to industrial enterprises, and the prosperous condition of the majority of those countries, the magnitude of the movement is at once apparent.

South America may be divided into three distinct zones, which differ materially in the extent of their electrical development, and in the kind of business and management of the plants. In the first place, the Atlantic zone, comprising Argentina and Brazil as its most important field, must be considered. In this region electrical industries are in a very advanced state of development. Buenos Aires, the progressive capital of Argentina, which is the largest and most advanced city of the southern hemisphere, having a population of a million inhabitants, is the most important seat of electrical industries in South America. One may have a very clear idea of the volume of the electrical business in that city when learning that

there are six large railway, lighting and power companies supplying electric current.

The power stations are in the outlying districts of the city and current is generated and distributed using voltages ranging between 1,000 and 6,000 volts, which is stepped down for use by means of transformers placed in sub-stations and cellars. The cost of power varies all the way from 2 to 15 cents per kilowatt-hour, depending on the quantity, voltage and location of the consumer. The generating stations use, to a great extent, American machinery and supplies, and the street car lines, exclusively, American motors and other railway apparatus. Atlhough the promoters and capitalists are from different countries, the control and management are mostly under Argentines or native Europeans who have become naturalized citizens.

One peculiarity of the electric street car systems in Buenos Aires is that they are seldom confronted by what is known as "rush hours." Street cars have at all hours of the day a large and uniform traffic. This is due to two causes: The city of Buenos Aires has its business and residential districts side by side; whatever be the direction and extent of the city's growth, both go together. In the second place, the southern metropolis is one of the best paved and most carefully kept cities in the world. There are a number of Alamedas and Avenidas (Boulevards and Avenues) which radiate from the center to the outskirts, on which no street cars or trucking is allowed, and along which thousands of automobiles, cabs and bicycles are constantly conveying pleasure seekers and business people every day in the year.

Brazil is another South American country where electric industries have progressed rapidly. The tendency, especially in Rio de Janeiro, is toward the consolidation of the most important plants. Not long ago it was learned that a syndicate composed of Canadian capitalists had effected a successful movement in that direction by taking control of all the street car and lighting plants of the city of Rio de Janeiro. The name of the corporation is the Rio de Janeiro Tramway & Light Company, and it is capitalized at $50,000,000. Rio de Janeiro, like Buenos Aires, has a very extensive system of trolley lines and lately has also taken up the building of electric suburban roads. By a decree dated April 5, 1904, the government of Brazil approved the basis of a contract presented by the Minister of Industries, Communications and Public Works, for the construction of an electric railway between Rio de Janeiro and the city of Petropolis, a distance of nearly 100 miles. This is a very important move, as it means an advanced step in the introduction of electric railways in the place of steam railroads.

A Brazilian state of growing importance and whose riches have attracted large numbers of German immigrants, is Sao Paulo. Here electric industries are well advanced. The Sao Paulo Light & Power Company lately awarded an important contract for further equipment to be installed in the hydro-electric plant on the River Tiete, located over 20 miles distant from the city of Sao Paulo. The additional machinery will include a 2,500-kw generator to be direct-connected to a turbine of 4,000 hp capacity. When the extension is completed the capacity of this plant will reach the 10,000-kw mark. The Sao Paulo plant was the first water power long-distance plant installed in Brazil, and the perfect satisfaction it has afforded will no doubt give impetus to the development of hydro-electric plants in a region very well adapted to that industry.

The second zone and the one which promises to become the most important to promoters and manufacturers of electrical machinery, in the near future, is the Pacific side of South America. Peru and Chile have within their borders about one-half the Andes Mountains. Their territories are crossed by a great number of rivers of torrential character, which are situated near large centers of population, mining properties and other prospective markets for electric power.

Mining industries have received a great impetus due to the facilities for obtaining power from hydro-electric transmission plants. There are a great many mines possessing their own water power plants and whose machinery, transportation and lighting are entirely done by electric power. The most important instance of this kind is furnished by the Cerro de Pasco Mining Company. This is a North American corporation, which some time ago purchased valuable copper and silver mining claims in Cerro de Pasco, Peru. These mines are located about 200 miles east of Lima and the Pacific Ocean, to which they are connected by a steam road, famous the world over as the highest and most difficult bit of railroading ever constructed. The mining concern has already begun the building of an 8,000-kw plant which will furnish power to be used in traction, lighting in addition to driving the machinery of the establishment.

Alongside the above-mentioned road is situated what is believed to be the highest voltage long-distance electric transmission in actual operation in South America. This is the plant of the Empresa Eléctrica de Santa Rosa (Santa Rosa Electric Corporation), whose distance of transmission is nearly 30 miles and the voltage used 33,500. This transmission plant is actually operating with a capacity of 4,500 hp, which energy is transmitted to Lima, where it is stepped down to 2,300 volts for local distribution. This plant is the latest development in the extension of the Santa Rosa Company. This concern originally built and operated a steam plant in Lima, using as fuel petroleum from Peruvian oil fields. Then, on the River Rimac, which passes through Lima, a low head dam was built to furnish power to turbines and generators; this was the first extension to the original plant. The above-mentioned 30-mile transmission plant, which takes power from the same river, is the second addition built by the company. Still this could not be called the last extension in this direction, as the river affords very good heads and perhaps more water from more distant places in its course. The building of more extensions higher and farther up the river would present a curious feeding system of hydroelectric power into an electric circuit, which would be exactly the opposite of a long railway feeder system, and where the water wheel plants would perform a similar rôle to that performed by rotary sub-stations.

Lima, which is one of the most important cities of the Southern Continent, is now lighted throughout by electric power, and in many manufacturing plants the machinery is driven by electric motors. A number of cotton and wool weaving plants have recently been equipped with motor-driven spindles and looms; there are also cigarette, soap, cracker, match and other factories which use electric motors to drive their machinery.

Two syndicates were recently formed in Lima for the construction and operation of trolley suburban car lines. One of them is to connect Lima with Callao, its seaport (already connected to the capital by two steam roads), and the other with a number of seashore resorts. The government gave the two syndicates a privilege for sixty-six years. The two companies are to be free of taxes and are to import free of duty for the term of two years all material for their own use. At the end of sixty-six years the cars, rolling stock and all material become the property of the government free of cost. Both the electric railway companies have purchased from North American manufacturers machinery, supplies and other material to equip the lines. Both these lines which are now in actual operation use power from the Santa Rosa company; besides the main power station in Lima there are two rotary sub-stations to furnish power along the line.

These are only a few of the latest developments in the western coast of South America. Chile and Bolivia are also becoming interested in hydro-electric developments. There are a number of mining companies in Chile availing themselves of the rapid course of Andean streams for generating electric current for driving their machinery, light their establishments and sometimes for traction. Ecuador has lately joined the general movement, too; Guayaquil, Quito and other important centers have already modern central station lighting plants, and the electric current will soon be used in other industries.

The third zone, which is composed of the republics of Colombia and Venezuela and the Guianas, is undoubtedly the best-known South American market among American exporters and promoters, because of its proximity to this country. One must acknowledge also that nearly all the electrical development in that region is due to American or Americanized business men. Herein lies the most important difference among the three zones: The Atlantic zone is the least known to American capitalists and exporters, and while there are many natives interested in the electric enterprises, the bulk of the business is controlled by Europeans or Europeans who have become naturalized. In the Pacific zone, however, most of, if not all, the electric concerns are financed and managed by natives. On the other hand, the northern or Caribbean zone is to a great extent financed and controlled by Americans. There is, however, one tendency throughout South America, which is to abandon European manufacturers and exporters in favor of Americans, as the people are made aware of the gigantic strides made by this country in electrical science and industry.

Single-Phase Commutator Motors.—II.

BY SEIJIRO SUGIYAMA.

OF the single-phase commutator motors, the simplest is the single-phase repulsion motor, in which the rotor coil, being short-circuited through the brushes, is entirely independent of the stator coil. Its ability to be used without a transformer, under high voltages, is its great advantage over the other motors,

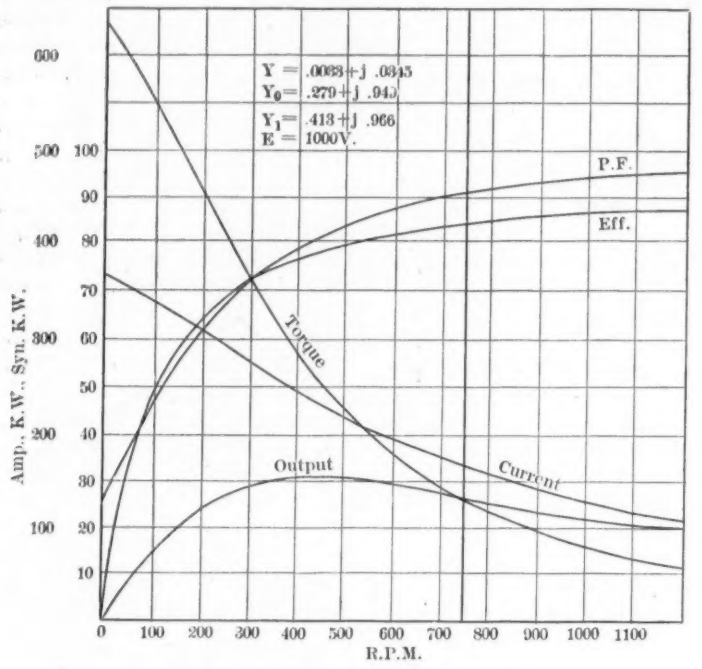


FIG. 12.—REPULSION MOTOR, $\Theta = 10°$.

which have somewhat better characteristics. Most probably it will be generally adopted as the alternating-current railway motor. Let us go further in investigating the characteristics of the single-phase repulsion motor.

Transforming the equations expressed in complex quantities to those in the absolute, the stator energy current is

$$\frac{E}{D}[(g^2+b^2)\{(g+g_1)(g_0^2+b_0^2)+g_0(g+g_1)^2+g_0(b+b_1)^2\}$$
$$+(g_0^2+b_0^2)\{(gg_1+bb_1)(b+b_1)+(bg_1-gb_1)(g+g_1)\}\sin^2\Theta$$
$$+(g_0^2+b_0^2)\{(gg_1+bb_1)(g+g_1)-(bg_1-gb_1)(b+b_1)\}S\sin\Theta\cos\Theta],$$

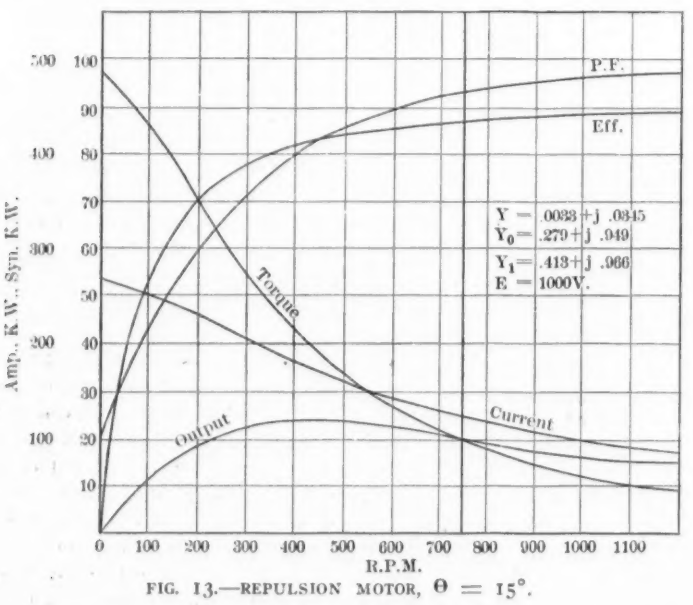


FIG. 13.—REPULSION MOTOR, $\Theta = 15°$.

the stator wattless current is

$$\frac{E}{D}[(g^2+b^2)\{(b+b_1)(g_0^2+b_0^2)+b_0(g+g_1)^2+b_0(b+b_1)^2\}$$
$$+(g_0^2+b_0^2)\{(gg_1+bb_1)(g+g_1)-(bg_1-gb_1)(b+b_1)\}\sin^2\Theta$$
$$+(g_0^2+b_0^2)\{(gg_1+bb_1)(b+b_1)+(bg_1-gb_1)(g+g_1)\}S\sin\Theta\cos\Theta],$$

the stator current is

$$I_0 = E\sqrt{\frac{(g^2+b^2)(g_0^2+b_0^2)\{(g+g_1)^2+(b+b_1)^2\}}{D}}$$

and the rotor current is

$$I_1 = E\sqrt{\frac{(g^2+b^2)(g_0^2+b_0^2)(g_1^2+b_1^2)(\cos^2\Theta+S^2\sin^2\Theta)}{D}}$$

where

$$D = (g^2+b^2)\{(g+g_0+g_1)^2+(b+b_0+b_1)^2\}+2[(gg_1+bb_1)\{g_0(g+g_0+g_1)+b_0(b+b_0+b_1)\}-(bg_1-gb_1)\{g_0(b+b_0+b_1)-b_0(g+g_0+g_1)\}]\sin^2\Theta+(g_0^2+b_0^2)(g_1^2+b_1^2)\sin_4\Theta+2[(gg_1+bb_1)\{g_0(b+b_0+b_1)-b_0(g+g_0+g_1)\}+(bg_1-gb_1)\{g_0(g+g_0+g_1)+b_0(b+b_0+b_1)\}]S\sin\Theta\cos\Theta+(g_0^2+b_0^2)(g_1^2+b_1^2)S^2\sin^2\Theta\cos^2\Theta.$$

Thus, with the increase of speed, the stator current tends to zero and the rotor current to a certain value, the exciting m.m.f. being shifted from the stator coil to the rotor. It is very interesting to note that the stator current vector describes a circle passing through the origin of the co-ordinates. Let x be the stator wattless current

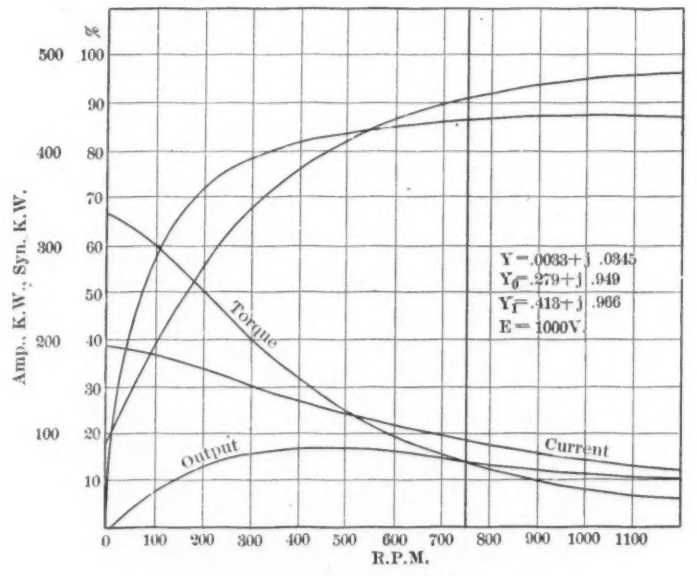


FIG. 14.—REPULSION MOTOR, $\Theta = 20°$.

and y the stator energy current; then eliminating S from the equations of the stator energy and wattless current, we get

$$(g_0^2+b_0^2)\{(gg_1+bb_1)(b+b_1)+(bg_1-gb_1)(g+g_1)\}Ex$$
$$+(g_0^2+b_0^2)\{(gg_1+bb_1)(g+g_1)-(bg_1-gb_1)(b+b_1)\}$$
$$Ey=[(gg_1+bb_1)\{g_0(g+g_0+g_1)+b_0(b+b_0+b_1)\}-$$
$$(bg_1-gb_1)\{g_0(b+b_0+b_1)-b_0(g+g_0+g_1)\}+$$
$$+(g_0^2+b_0^2)(g_1^2+b_1^2)\sin^2\Theta](x^2+y^2).$$

The torque is

$$T = E^2\left\{\frac{(g_0^2+b_0^2)}{D}\{b(g_1^2+b_1^2)+b_1(g^2+b^2)\}\sin\Theta\cos\Theta\right.$$
$$\left.-\frac{(g_0^2+b_0^2)}{D}\{g(g_1^2+b_1^2)+g_1(g^2+b^2)\}S\sin^2\Theta\right],$$

and the power is $P = ST$.

Thus, the torque at a certain displacement is maximum at starting, decreases with the increase of speed, becomes zero at a very high speed, reaches negative maximum and then tends to zero. The speed at which the torque becomes zero or the theoretical maximum speed is

$$S = \frac{b\,(g_1^2 + b_1^2) + b_1\,(g^2 + b^2)}{g\,(g_1^2 + b_1^2) + g_1\,(g^2 + b^2)}\,cot\,\Theta.$$

The torque and the torque per kilovolt-ampere input at any speed are zero at zero displacement. With increase of the displacement,

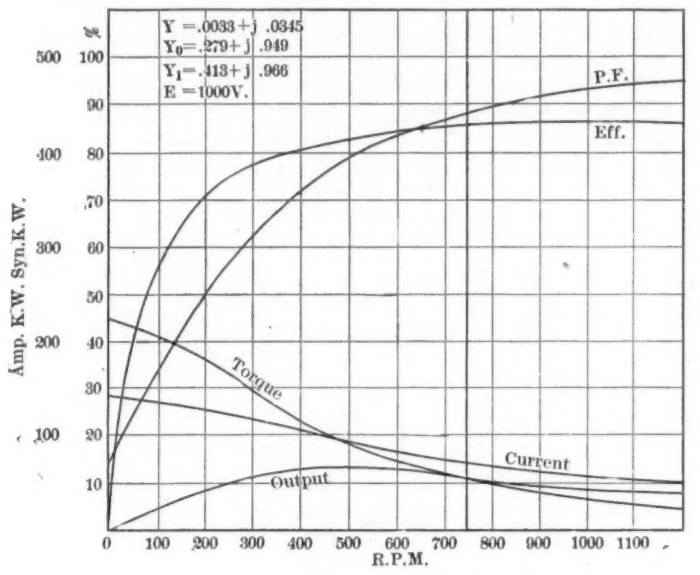


FIG. 15.—REPULSION MOTOR, $\Theta = 25°$.

they increase rapidly to maximum and decrease slowly to zero, where the displacement of the maximum torque is smaller than that of the maximum torque per kilovolt-ampere input. The starting torque per kilovolt-ampere input is evidently maximum, when

$$sin^2\,\Theta = \frac{\sqrt{A\,(A+B+C)} - A}{B+C};$$

where $A = (g^2 + b^2)\,\{(g + g_0 + g_1)^2 + (b + b_0 + b_1)^2\}$,

$$B = 2\,(gg_1 + bb_1)\,\{g_0\,(g + g_0 + g_1) + b_0\,(b + b_0 + b_1)\} - 2\,(bg_1 - gb_1)\,\{g_0\,(b + b_0 + b_1) - b_0\,(g + g_0 + g_1)\}$$

and $C = (g_0^2 + b_0^2)\,(g_1^2 + b_1^2)$.

As seen, the single-phase repulsion motor may be controlled by

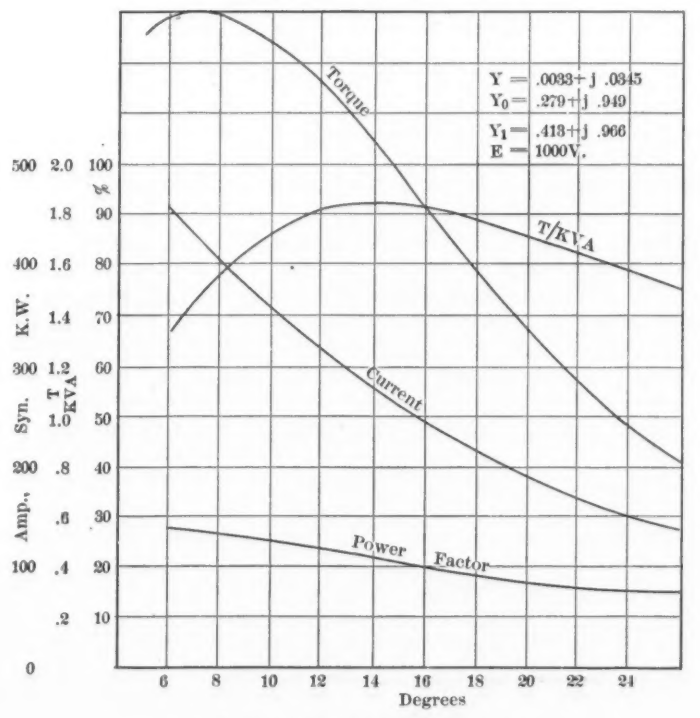


FIG. 16.—REPULSION MOTOR, $S = 0$.

changing the impressed e.m.f. or the displacement. In general, the currents in the motor are smaller with displacement control than with potential control. This advantage of displacement control is accompanied by its disadvantage of bad sparking with large displacements.

As example, the calculated characteristics of a single-phase repulsion motor, with various displacements and at various speeds, are

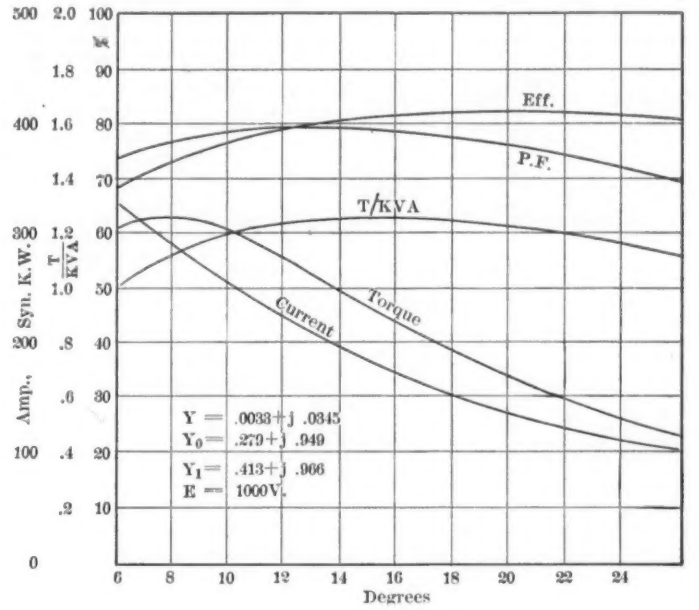


FIG. 17.—REPULSION MOTOR, $S = .5$.

shown in Figs. 12, 13, 14, 15, 16, 17, 18 and 19, the motor having four poles and operating on a 25-cycle circuit.

DISCUSSIONS.

In the foregoing theory, we assumed that the exciting admittance, the stator admittance and the rotor admittance are constant. While the stator and the rotor admittance are practically constant, the exciting admittance is variable, as the exciting conductance, g, depends on the speed, and the exciting susceptance, b, on the saturation.

Regarding the power factor, the effect of the short-circuited coils under the brushes, which we neglected, is very important. In the single-phase repulsion motor, let, in vector denotation,

$I_1 - I_0\,cos\,\Theta + j\,S\,I_0\,sin\,\Theta - j\,S\,I_2$ I_1

I_2 = the current of the short-circuited coils, reduced to that of the stator,

Y_2 = the admittance of the short-circuited coils, reduced to that of the stator, and

$C_2 = Y/Y_2$;

then the fundamental equations are

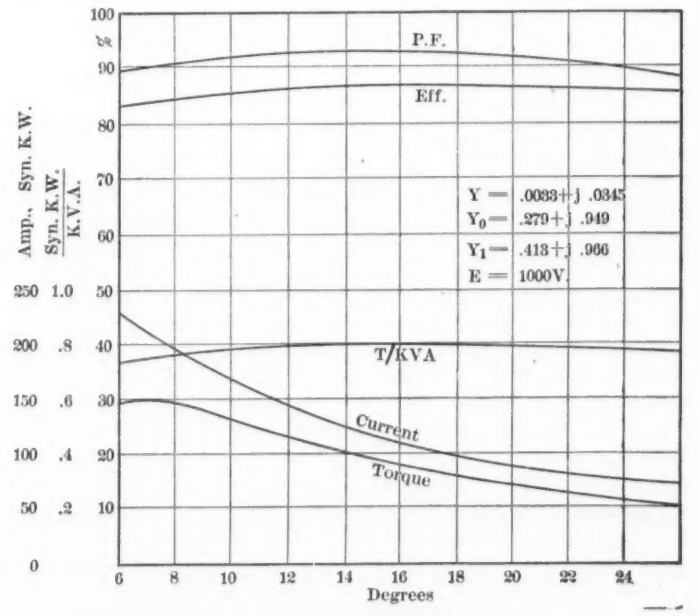


FIG. 18.—REPULSION MOTOR, $S = 1$.

$$\frac{I_0 - I_1\,cos\,\Theta - I_2\,sin\,\Theta}{Y} + \frac{I_0}{Y_0} = E,$$

$$\frac{I_1 - I_0 \cos\theta + jSI_0 \sin\theta - jSI_2}{Y} + \frac{I_1}{Y_1} = 0,$$

and $$\frac{I_2 - I_0 \sin\theta - jSI_0 \cos\theta + jSI_1}{Y} + \frac{I_2}{Y_1} = 0;$$

that is, $I_0(1 + C_0) - I_1 \cos\theta - I_2 \sin\theta = EY,$

$I_0(\cos\theta - jS\sin\theta) - I_1(1 + C_1) + jSI_2 = 0,$

and $I_0(\sin\theta + jS\cos\theta) - jSI_1 - I_2(1 + C_2) = 0.$

Solving the simultaneous equations, we obtain

$$\frac{EY}{C_0 + C_1\cos^2\theta + C_2\sin^2\theta + C_0C_1 + C_0C_2 + C_1C_2 + C_0C_1C_2 - S^2C_0 + jS(C_2 - C_1)\sin\theta\cos\theta}$$

$$= \frac{I_0}{(1 + C_1)(1 + C_2) - S^2}$$

$$= \frac{I_1}{(1 + C_2)(\cos\theta - jS\sin\theta) - S^2\cos\theta + jS\sin\theta}$$

$$= \frac{I_2}{(1 + C_1)(\sin\theta + jS\cos\theta) - S^2\sin\theta - jS\cos\theta}$$

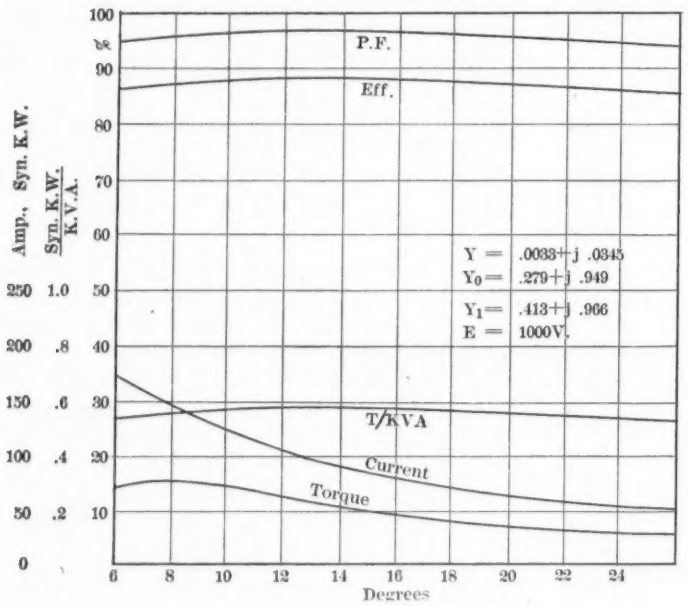


FIG. 19.—REPULSION MOTOR, $S = 1.5$.

$$P = jS\frac{I_0}{Y} \times (I_1 \sin\theta - I_2 \cos\theta)$$

and $$T = j\frac{I_0}{Y} \times (I_1 \sin\theta - I_2 \cos\theta).$$

Thus, the power factor of the single-phase repulsion motor is higher at low speed and lower at high speed, when C_2 is finite than when C_2 is infinite.

We assumed a sinusoidal distribution of the m.m.f's; but the distribution of the m.m.f. of the full-pitch, direct-current winding is in the form of an equilateral triangle. The equilateral triangular distribution may be decomposed into a fundamental harmonical and a triple harmonical distribution. Though the effect of the triple harmonic is insignificant in the single-phase commutator motors, mentioned above, it is vitally important in the Milch single-phase repulsion induction motor, which starts with a large torque, as a single-phase repulsion motor, and runs up to a little beyond synchronism, as a single-phase induction motor.

It is provided with two sets of brushes, displaced by 90° from each other, as shown diagrammatically in Fig. 20.

Let, in vector denotation,

I_1 = the first rotor current, reduced to the stator,

I_2 = the second rotor current, reduced to the stator,

Y = the exciting admittance, neglecting the triple harmonic,

$p = 1/9$ the ratio of the amplitude of the triple harmonic to that of the fundamental,

and θ = the angle between the axes of the stator and the first rotor coil;

then the fundamental equations are:

$$\frac{I_0 - I_1\cos\theta - I_2\sin\theta}{Y} + \frac{P(I_0 - I_1\cos 3\theta + I_2\sin 3\theta)}{Y} + \frac{I_0}{Y_0} = E,$$

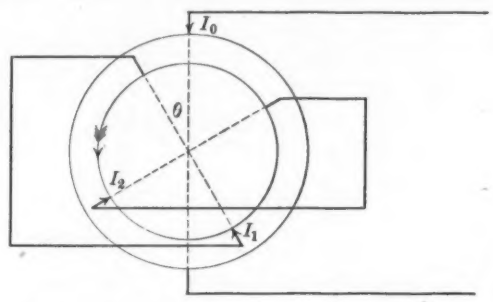


FIG. 20.—MILCH INDUCTION REPULSION MOTOR.

$$\frac{I_1 - I_0\cos\theta}{Y} + \frac{P(I_1 - I_0\cos 3\theta}{Y} + jS\frac{I_0\sin\theta - I_2}{Y} + jS\frac{3P(I_0\sin 3\theta + I_2)}{Y} + \frac{I_0}{Y_1} = 0$$

and $$\frac{I_2 - I_0\sin\theta}{Y} + \frac{P(I_2 + I_0\sin 3\theta}{Y} + jS\frac{I_1 - I_0\cos\theta}{Y} + jS\frac{3P(I_0\cos 3\theta - I_1)}{Y} + \frac{I_2}{Y_1} = 0.$$

Solving the simultaneous equations, we have, at starting,

$$I_0 = \frac{1 + P + C_1}{(1 + P)(C_0 + C_1) + C_0C_1 + 4P\sin^2 2\theta} EY,$$

$$I_1 = \frac{\cos\theta + P\cos 3\theta}{(1 + P)(C_0 + C_1) + C_0C_1 + 4P\sin^2 2\theta} EY,$$

$$I_2 = \frac{\sin\theta - P\sin 3\theta}{(1 + P)(C_0 + C_1) + C_0C_1 + 4P\sin^2 2\theta} EY,$$

and $$T = j\frac{I_0}{Y} \times \{I_1(\sin\theta + 3P\sin c\theta) - I_2(\cos\theta - 3P\cos 3\theta)\}$$

$$= j\frac{I_0}{Y} \times \frac{4P\sin 4\theta}{1 + P + C_1} I_0.$$

Thus, but for a triple harmonic in the distribution of the m.m.f., the single-phase repulsion induction motor, being a single-phase induction motor, has no starting torque.

Telephones on Special Touring Train.

The Merchants and Manufacturers' Association, of Pittsburg, Pa., is touring western Pennsylvania and Ohio in a special train composed of eight Pullman cars, each car being equipped with a telephone, so that the members of the association can converse with one another without leaving their seats. The telephones are also arranged to be connected to the long-distance lines at places where the train stops for more than half an hour. This arrangement of telephone service has proven to be very useful and has been highly complimented by the members of the Merchants and Manufacturers' Association and the press representatives. It was designed and installed by the Central District & Printing Telegraph Company (the Pittsburg local Bell Telephone Company) under the supervision of Mr. S. P. Grace, the company's chief engineer. In the stateroom of the newspaper men's car a long-distance telephone was installed. When Steubenville was reached connection was made, by means of a plug, between the train and the city telephone system, and President Lloyd, of the association, had a lengthy chat with Mayor Hays at Pittsburg. The various members of the association then took turns in using the telephone and made 50 calls in

30 minutes. It is stated that the conversation between the extreme points was very clear and distinct. When the train resumed its journey the telephones in the various cars were interconnected and conversation carried on while the train was traveling at a high speed.

It is stated that negotiations are now pending by which each Pullman car will be equipped with a telephone, thus enabling passengers to communicate with the local and long-distance systems from any station. It is also proposed to provide a telephone in each berth for communication with the porter and between the cars composing the train.

Economics of a 200-Mile Transmission.

BY J. EUGENE WALLACE.

IT is a fact well understood among transmission engineers that certain line efficiencies give better commercial results than others. Again, engineers understand that an efficiency that may deliver the cheapest kilowatt does not necessarily return the greatest income per kilowatt generated; but it is, perhaps, not so generally understood that the efficiency which will return the largest profit per kilowatt generated does not always return the largest percentage of profit on the total capital invested in a transmission enterprise.

Engineers who have had the work in hand of deciding on voltages and line efficiencies in connection with a transmission scheme have usually reached a decision through a process of laborious calculation. The writer for some time past has been engaged in crystalizing this process of calculation in a few simple rules and formulas, and the following is illustrative of a few points in connection with a study which it is expected will be made public in extenso at a not distant date.

A transmission enterprise will be assumed under the following conditions:

That a water power of 10,000 kw is developed for transmission a distance of 200 miles.

That Q, the cost of energy at the power house terminals, is $15 per kw-year of 8,760 kw-hours.

That S, the market price of a kilowatt-year, is $50.

That G, the capital invested in the generating plant, is $200 per kw generating capacity of the station.

That O, the capital invested in right of way, pole construction, insulators, etc., is $20 per kw generating capacity of the station. A 200-mile pole line is assumed as costing $200,000.

That P, the annual interest, maintenance and depreciation charge on the pole line, etc., is $2 per kw station capacity.

That U, the annual interest, maintenance and depreciation charge on the line conductors, is 10 per cent.

That q, the price of copper delivered, is 16 cents per pound.

M is a symbol representing the product of all the line constants, specific weight of conductor, specific resistance of conductor, price per pound of conductor, square of the distance transmitted, annual charges on the line conductor, U, and a constant dependent on the style of transmission.

That E represents the voltage generated and delivered to the transmitting line.

f represents the power factor at the receiver circuit, which will be considered unity.

Y represents the cost of a delivered kilowatt-year.

n represents the efficiency of the transmitting line.

F represents the load factor on the line.

N represents the ratio of $\sqrt{mean^2}$ current divided by average current.

The cost of a delivered kilowatt is made up of three items—the cost of power absorbed from the power house terminals, the annual charges on the line conductor, and the annual charges on the right of way, pole construction, etc.

The cost of power absorbed from the power house terminals, per kilowatt delivered, varies in inverse ratio to the line efficiency.

The capital invested in conductors, per kilowatt delivered, varies as the square of the distance and inversely as the square of the voltage, multiplied by a function of the efficiency; therefore, the annual charges are represented by $\frac{M}{f^2 E^2 n (1 - n)}$.

At any voltage practically suited to a transmission, the capital invested in pole construction and insulators can be called a constant. Indeed, it might be called a fixed amount at all voltages, for as the potential decreases the cost of insulation would decrease, but the cost of pole construction would increase due to the added weight of wire it would be found necessary to use. Assume that pole construction is a constant, the amount to charge annually to a delivered kilowatt varies in inverse ratio to the efficiency of the line.

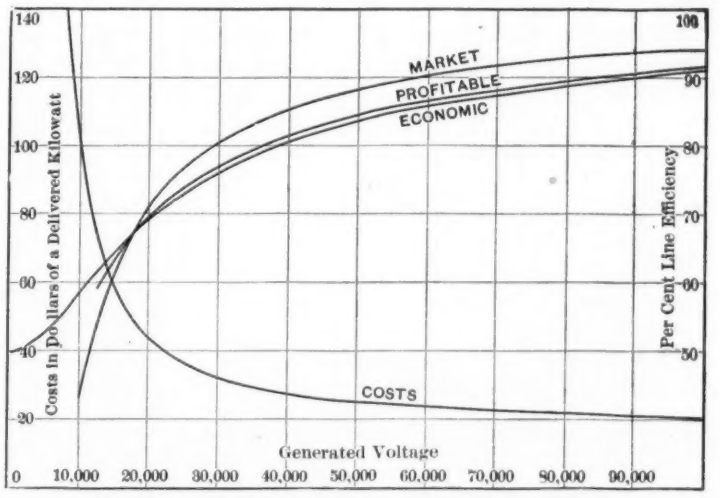
Upon these assumptions the following formula represents the minimum cost of a delivered kilowatt, in known terms of voltage and line constants:

$$Y = Q + \frac{P}{FN} + 2\frac{M}{f^2 E^2} + 2\sqrt{\frac{M}{f^2 E^2}\left(Q + \frac{P}{FN} + \frac{M}{f^2 E^2}\right)};$$

and the efficiencies that obtain the above results are represented thus:

$$n = \frac{Q + \frac{P}{FN} + \frac{M}{f^2 E^2} - \sqrt{\frac{M}{f^2 E^2}\left(Q + \frac{P}{FN} + \frac{M}{f^2 E^2}\right)}}{Q + \frac{P}{FN}}$$

In the accompanying illustration is given a curve showing the minimum cost of a delivered kilowatt at any transmitting voltage,



CURVE OF MINIMUM COST PER KILOWATT DELIVERED.

developed by the use of the above formula. The curve presents a very interesting and practical fact for the use of the engineer in his decisions regarding potentials, namely, *that additional voltage does not materially decrease the cost of delivered power after certain potential values are reached.* It will be observed that at 60,000 volts the curve has become nearly a straight line, and the cost, from that point on, decreases very slowly; therefore, independent of any considerations regarding insulation or climatic conditions, 60,000 volts give about all a transmission, working under the conditions assumed, has to offer. This is not in accordance with the usually accepted theory—that cost varies in inverse ratio to the square of the voltage.

On the sheet is a curve marked "economic," developed by the above formula. The curve shows at all voltages the efficiency that delivers a kilowatt at minimum cost, and is the efficiency that should be used if the commercial conditions demand the cheapest delivered kilowatt.

If the plant has a market in sight for all the energy it can deliver at a stated price, the efficiency that will return maximum net income per kilowatt generated and delivered to the line is found by the use of the following formula:

$$n = 1 - \sqrt{\frac{M}{f^2 E^2 S}}$$

The curve marked "market" was developed by the use of the above formula. Market efficiency will be noted as being a high efficiency; in fact, it is the highest efficiency any economic consideration of a set of conditions will give, and therefore, from the standpoint of regulation or good operation, it is very desirable.

Inspection of the two formulæ given for efficiency will reveal the fact that neither contains all the factors that have an influence on the percentage of profits that might be earned on the whole capital invested in plant and line. At a given voltage market efficiency is affected only by the cost of copper and the market price of energy.

Economic efficiency is only in an indirect manner influenced by the cost of the generating plant.

The formula that contains all the factors that have any bearing on percentage of profits, and referring to maximum percentage of profit on the total capital invested in plant and line, is as follows:

$$n = 1 + \frac{M}{f^2 E^2 (G+O) U} - \sqrt{\left(1 + \frac{M}{f^2 E^2 (G+O) U}\right)^2 + \frac{M}{f^2 E^2 S}} - \sqrt{\left(1 + \frac{M (S+Q+P/FN)}{f^2 E^2 (G+O) U S}\right)}$$

Profitable efficiency, as developed by the above formula, usually lies between economic efficiency and market efficiency. In this instance it does not differ materially from economic efficiency.

It will be noted that all these efficiencies converge and pass through a point at approximately 17,400 volts. This point of intersection marks the critical voltage of a transmission between a paying and non-paying basis. Above critical voltage a transmission can pay profits; below it cannot earn the annual charges and operating expenses.

The curves given herewith are based on unity load factor, which does not exist in any station known to the writer. The minimum effects of load factor on the cost of delivered energy is to increase the conductor losses (watt losses) and conductor charges (interest, etc.) by a multiplier which in value is the ratio, N, of the $\sqrt{mean^2}$ current to the average current. Since the watt losses correspond to the $\sqrt{mean^2}$ current and the power transmitted corresponds to the average current, to preserve the economic relation between line losses and line charges the line should be designed to $\sqrt{mean^2}$ current, instead of average current. The constant for pole construction is increased relatively by a divisor, which in value is the average current, or load factor; and since the other two items of the cost of a delivered kilowatt are increased by the factor, N, the proper relation between pole construction and conductor losses and charges is preserved by further dividing pole construction by the factor, N. Hence, in the various formulas we have pole construction represented thus: P/FN, on account of load factor. In passing it might be well to mention that the generating cost of energy naturally increases as the load factor decreases. However, several lines radiating from a power house might give a resultant load factor approaching unity. Doubtless the efforts of the management would be in that direction.

The above table is an analysis of the earnings of our assumed transmission, using 60,000 volts, and the various efficiencies that have been mentioned.

LOAD-FACTOR = 1.

Item.	Market Efficiency.		Profitable Efficiency.		Economic Efficiency.	
Per cent. efficiency	90.45		86.83		86.00	
Market price	$50.00		$50.00		$50.00	
Generating cost	$15.00		$15.00		$15.00	
Loss of profit on energy absorbed by the line	3.345		4.615		4.90	
Cost of energy absorbed by the line	1.435		1.975		2.10	
Annual copper charges	4.76		3.45		3.26	
Annual pole charges	2.00	26.54	2.00	27.04	2.00	27.26
Profit		$23.46		$22.96		$22.74
Generator investment	$200.00		$200.00		$200.00	
Copper investment	47.50		34.50		32.60	
Pole investment	20.00		20.00		20.00	
Total investment	$267.60		$254.50		$252.60	
Per cent. profit	8.8		9.025		8.99	

LOAD-FACTOR = .55 $\sqrt{mean^2}$ current = .66.

	Market Efficiency.		Profitable Efficiency.		Economic Efficiency.	
Average per cent. efficiency	90.45		86.94		86.50	
Market price	$27.50		$27.50		$27.50	
Generating cost	$8.25		$8.25		$8.25	
Loss of profit on the energy absorbed by the line	1.873		2.51		2.60	
Cost of the energy absorbed by the line	.947		1.293		1.335	
Annual copper charges	3.14		2.287		2.225	
Annual pole line charges	2.00	16.21	2.00	16.34	2.00	16.41
Profit		$11.39		$11.16		$11.09
Generator investment	$200.00		$200.00		$200.00	
Copper investment	31.40		22.87		22.25	
Pole line investment	20.00		20.00		20.00	
Total investment	$251.40		$242.87		$242.25	
Per cent. profit	4.53		4.6		4.58	

"On the Road to Mandalay."

One of the latest and most interesting of the trolley systems to be built in the Far East is that which has lately gone into operation at Mandalay, British Burmah. It is interesting as an example of the opportunities still awaiting the electrical engineer and manufacturer in Asia and of the ready acceptance of the new facilities by the local population, insuring success to the enterprise.

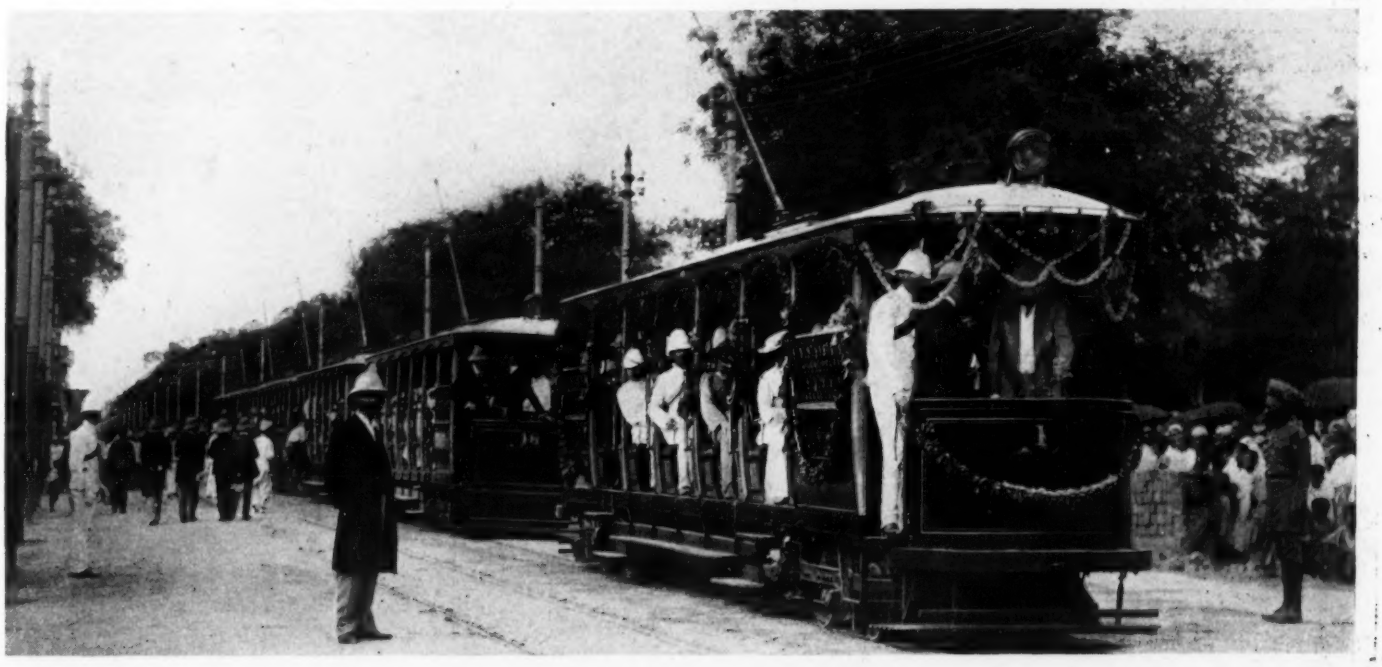
The road has a route length of 7 miles, double track throughout, the rails being 6 in. deep, with a 1¼-in. groove, laid to a gauge of 3 ft. 6 in. in 45-ft. lengths, with a proportion of shorter lengths to allow for piecing in and closures. Double spikes hold the rails to hardwood sleepers, which are laid at 2 ft. 9 in. centers, the whole resting on a ballasted bed, the road surface being made up with macadam in the ordinary way. Joints are of the plain type, secured with six-holed fishplates and double-bonded with two 4/0 B. & S. Neptune pin bonds, the usual cross and intertrack bonds being provided. The overhead equipment is on the span-wire system, a double line of trolley wire being used throughout. Standards are made up of solid-drawn weldless steel tubes, and have an over-all length of 28 ft.; they are set 6 ft. deep below the upper surface of the rails, the excavation being entirely filled with concrete. The trolley wires consist of hard-drawn copper 0.364 in. diameter, with a breaking strain of 23 tons per square inch. Section insulators are provided so that each half mile of trolley can be controlled separately if required, and lightning arresters of the Garton-Daniels type have been provided at every half mile. The feeder system, which is a somewhat elaborate one for a Far Eastern tramway, consists of solid soft-drawn copper wire, carried on special high-resistance toggle clamp insulators, which are in turn bolted to substantial malleable-iron brackets attached to the poles. At several points along the route of the tramways these feeders are tapped by insulated cables, which are connected to the main feeder switches in switch pillars fixed on the sidewalk in a manner similar to that used with underground feeders.

The rolling stock consists of 24 electric motor cars of the single-deck, open cross bench type. The cars have all the very latest improvements, and were built for Dick, Kerr & Co. by the Electric Railway & Tramway Carriage Works, Limited, Preston. Special care has been taken in designing the cars to insure the interchangeability of all the important parts entering into the construction of the rolling stock. The car bodies are 35 ft. 4½ in. in length, about 6 ft. wide and are designed to provide seating accommodation for 48 passengers. The floor frames are built of well-seasoned teak in combination with steel sections of such members and sizes as to insure maximum strength and minimum weight. Openings are arranged in the frame over the motors to afford convenient access to the armature brushes and to all bearings requiring frequent inspection and oiling. The platform floor frames are formed of teak timbers extending under the main floor frame as far as possible without interfering with the clearance of the trucks, and project out from each sill 3 ft. to provide room for the brake shaft and controllers.

The trucks upon which the cars are mounted are of the Brush Company's single type, suitably built to support the car bodies and to receive the motors and gearing. Each car is fitted with a complete electrical equipment, consisting of two Dick-Kerr standard 25 B traction motors, each capable of delivering approximately 28 hp, the temperature of the various parts not exceeding 75° C., after running at full load for one hour. The controllers are of the same firm's standard D.B.I. form "C" type, specially arranged with resistances for emergency braking, operated by the driving handle, which may be utilized either when the car is proceeding forward or backward. On the company's site in Seventy-eighth Street a power house has been erected, together with the necessary offices, car shed and repair shops. The steam plant consists of three B. & W. water tube boilers, working at a pressure of 160 pounds per square inch, each boiler being provided with a superheater fitted with all the usual accessories. There is also a water storage tank with a capacity of 20,000 gallons of water, a fuel economizer and two double-acting, single-cylinder feed pumps, each capable of delivering 2,000 gallons of water per hour. The three Belliss engines are compound, two-crank type, mounted on bedplates extended to take the directly coupled generators; each engine is fitted with a heavy fly-wheel and steam separator and is capable of delivering a normal output of 300 British hp, when running at 400 r.p.m. non-condensing and at a

steam pressure of 155 pounds per square inch at the stop valve. Coupled to each engine is a continuous-current compound-wound generator, having an output of 200 kw at 500 to 550 volts when running at 400 r.p.m., and designed to give an overload of 20 per cent. for 2½ hours with a moderate rise of temperature. The generators are in accordance with the standard practice of Dick, Kerr & Co., the magnet frames being of cast iron and the pole pieces of laminated steel, cast into the magnet frame. Commutation is said to be sparkless at all loads and the field windings are so arranged to give a 10 per cent. rise in the e.m.f. from no load to full load.

The switchboard was built by Messrs. Dick, Kerr & Co., and consists of nine black enameled slate panels 1½ in. thick, each supported independently on an iron frame. There are three generator, four feeder, one station lighting and one "Board of Trade" panel. Each generator panel is provided with two single-pole switches, one equalizing switch to connect the shunt of the compound-wound dynamo on to the equalizing bus-bar, one shunt field rheostat to enable the e.m.f. of the generator to be raised and lowered 50 volts, one field switch with resistance and pilot lamp, one main ammeter and an automatic circuit-breaker with magnetic blow-out. Each feeder panel is provided with one main single-pole switch, one automatic circuit-breaker and one ammeter. On the testing panel are all the necessary instruments and switches for recording or measuring leakage; also a recording voltmeter for recording the difference in potential between the terminus ends of the rails and the negative bus-bar. The station circuit panel is mounted with all the necessary switches and fuses, together with the ammeters required for station lighting and motor circuits. The road is the property of the Mandalay Electric Company, which has a capital of $1,000,000, and the system is the first electric one to go into operation in Burmah, British India.



VIEW ON MANDALAY ELECTRIC RAILWAY LINE.

The New York Central Power House.

A few details have been forthcoming as to the new power house at Glenwood, Yonkers, for the New York Central Railroad, designed by Mr. C. Wellesley Smith. Simplicity without plainness, but with every indication of power, is the dominating feature of the structure. It is to be 235 ft. long, 167 ft. wide and 125 ft. high, a great solid pile of masonry. In style it is classic, with a slight leaning toward the French, with russet brick trimmed with buff and terracotta. From the base to a height of 18 ft. the walls are Maine granite, the russet and buff rising above. The roof is to be of red Spanish tiles. The cornices are to be of decorated terracotta. The general side effect will be that of an arcade with end pavilions, produced by the long line of windows. Each window, which is to be crowned with a deep arching of buff brick, is 25 ft. high and 10 ft. wide, everything else aiding in carrying out the idea of size, stability and power. The two masonry smokestacks begin with a diameter of 24 ft. at their bases, where they rest upon a steel structure, and will taper to 18 ft. 6 in. at the rim 290 ft. above ground. The flues inside are to have a diameter of 17 ft.

Among the marked features of the structure is the manner in which the coal delivery track and elevator are to be enclosed in masonry to harmonize with the general architectural scheme. The cars unloading their coal for the power house run into the building and are thus hidden. The coal is to be taken from the cars by bucket or belt conveyor and transported to the great bins on the roof. These bins will hold 6,000 tons of coal without trimming, and for the purpose of fire protection the coal storage is in three separable bins. In addition to the delivery of coal by railroad, spur tracks being provided for, there will be a delivery tower on the outward end of the reservation to receive coal arriving by boat.

The high-tension electric switches will be grouped in an adjoining structure instead of in the power house. They will be controlled from a "dummy" board in the power station so that in case of accident the current can be cut off from the station itself. The current to be developed for the operation of trains in the Park Avenue tunnel and probably later as far as Croton on the Hudson Division and White Plains on the Harlem Division, will be generated by sixteen General Electric steam turbines already illustrated and described in these pages. Each of these turbo-generators will be a single unit, that is not dependent in any way upon its fellows nor upon the boilers supplying steam to them, but upon its own boilers. In this way each of the six generators is a separate and complete electric plant.

The plant will develop, normally, 30,000 kw, but the maximum peak load will be in excess of that. The indicated horse-power of the boilers will be 24,000. Twelve batteries of boilers are to be set up on the floor below the turbine room. The room in which the turbines and the dynamos are to be set up will be 104 ft. from floor to ceiling and 55 ft. wide in the clear. The trim of the room is white enameled and colored brick to a height of 10 ft. above the floor. Above this line the interior walls will have a facing of vitreous buff brick. There will be no exposed woodwork anywhere in the structure. Very little wood at all will be used, and this will be metal covered. The entire structure is to rest upon a pile foundation which acts as the bed for a 4-ft. base of steel-reinforced concrete. It was impossible to find rock upon which to rear the building, although drills were sunk to a depth of 143 ft. In the case of the Port Morris power house, which is to be identical in design and equipment with the one at Glenwood, rock was found at an average depth of about 25 ft. below ground, and foundations were carried down to and rest on rock.

Some Alternating Current Experiments at the Louisiana Purchase Exposition.

Of the exhibits in the Palace of Electricity one that has proven a constant source of interest to visitors is that of Mr. C. H. Thordarsen. This exhibit carries out the foremost idea of the Exposition management, it being a working exhibit for carrying on experiments

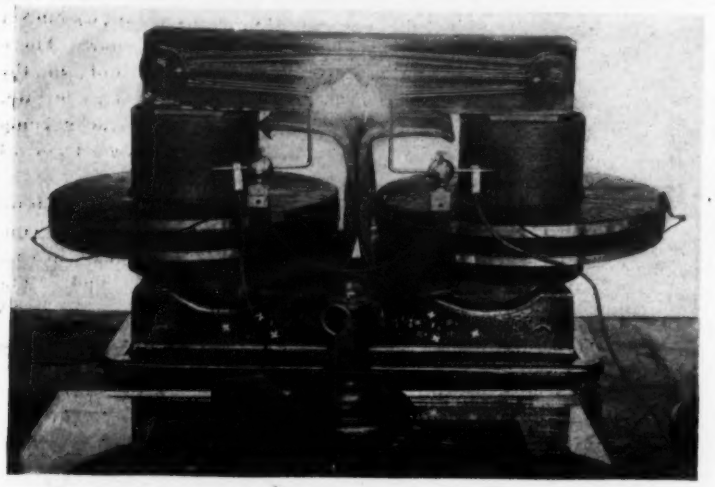


FIG. 1.—40,000-VOLT, 4-KW TRANSFORMER DISCHARGING THROUGH A 4-INCH GAP.

with alternating currents. In addition to instructing visitors in the fundamental principles of alternating currents, the exhibit is designed to show with what convenience and certainty more than

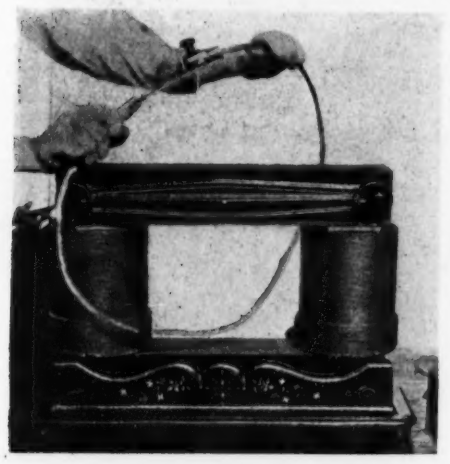


FIG. 2.—FUSING A NO. 13 WIRE BY CURRENTS GENERATED IN A SINGLE LOOP.

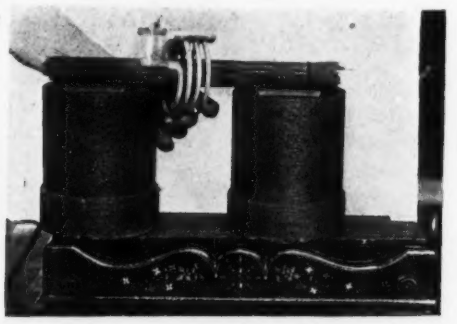


FIG. 3.—GENERATION OF CURRENT IN SECONDARY COIL.

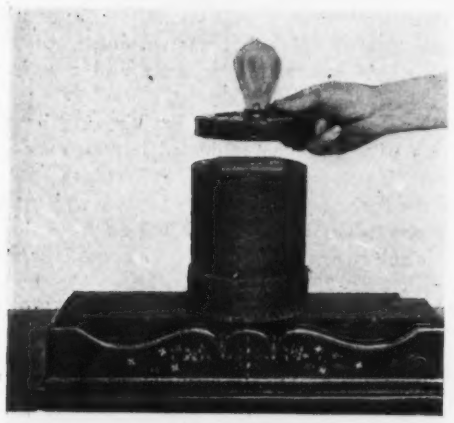


FIG. 4.—EXPLORING THE MAGNETIC FIELD WITH AN INCANDESCENT LAMP.

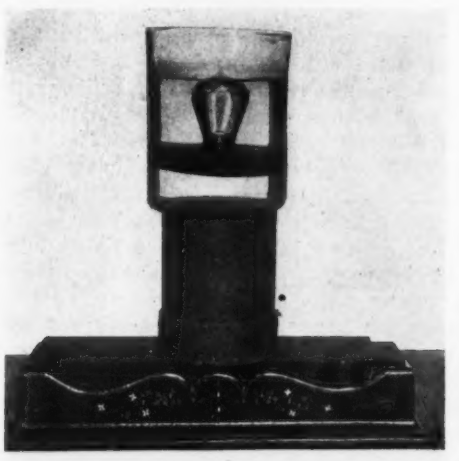


FIG. 5.—16-CP LAMP LIGHTED UNDER WATER.

fifty experiments may be demonstrated with a limited amount of apparatus. By a few changes the same apparatus may be employed in performing a number of experiments, thus reducing to a minimum the expense to colleges and schools and other institutions where it is desired to perform the experiments. One important piece of apparatus employed is a 5-kw, 60,000-volt transformer. This is so built that it may be readily taken apart, showing all details of construction. Primary and secondary coils of different windings may be slipped over the cores to obtain different results.

The series of experiments is begun by showing the length of discharge possible with the transformer. Between points a 4-in. spark is produced. The appearance of the discharge is varied first by using points as terminals, then by the use of a ball and point, and finally, by inserting a condenser on the secondary circuit, and by means of this obtaining a high-frequency discharge. In Fig. 1 the apparatus is shown discharging with a condenser in the circuit.

The generation of current in a single loop of wire is an interesting experiment. A loop of heavy, flexible wire is placed around the yoke of the transformer, as shown in Fig. 2. A No. 10 copper wire joining the terminals of the loop is at once heated to incandescence and melted.

Several experiments follow showing the effects on different objects of a strong alternating magnetic field. The transformer is quickly adapted to these by removing the secondary coil and the top yoke. An aluminum ball held above one of the cores is caused to rotate by the attraction of parallel currents generated in a plate held between the ball and the magnet in such a position as to produce the requisite torque. The direction of rotation may be reversed by placing the plate under the opposite side of the ball. An experiment demonstrating in an impressive manner the generation of current in a secondary coil is performed by means of a spiral of four turns of heavy wire, the terminals of which are joined by a very much smaller conductor. When the coil is placed as in Fig. 3, the insulation of the small wire is at once seen to smoke and in a short time the wire itself assumes a white heat.

A 16-cp incandescent lamp is employed in a novel experiment. The lamp is placed in the center of a small coil of several turns of wire, and connected in circuit with the coil. When the coil is held in the field with its plane at right angles to the axis of the field, as in Fig. 4, the lamp is caused to burn far above its normal candle-

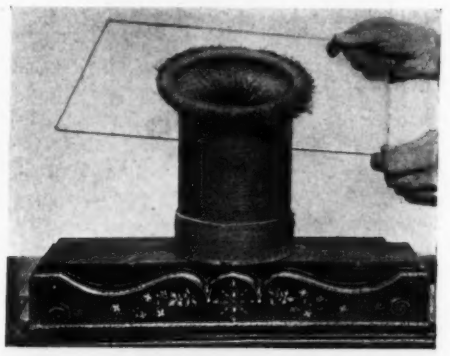


FIG. 6.—IRON FILINGS SURROUNDING A COPPER RING IN THE MAGNETIC FIELD.

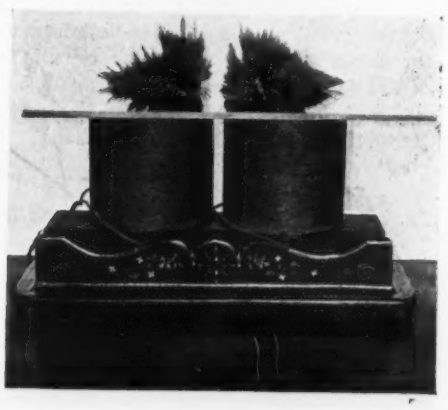


FIG. 7.—IRON FILINGS OVER POLES OF LIKE MAGNETISM.

power. By means of this apparatus the magnetic field may be explored, the strength of the field within the coil being noted by the color of the filament. When the coil and the lamp are immersed in water, as in Fig. 5, the lamp burns equally well. In this experiment

the repulsion of the coil is very noticeable by its rising to the top of the jar when the current is turned on; this repulsion, of course, being due to the currents generated in the coil.

Some effects which puzzle the layman are produced by placing over the pole pieces discs of copper, aluminum, brass and iron. The copper and aluminum discs are immediately floated off, because

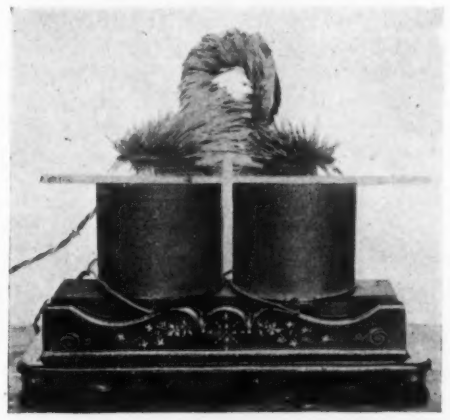


FIG. 8.—DISTORTED MAGNETIC FIELD DUE TO CURRENT IN VERTICAL COIL.

of the repulsion effect of the currents induced In them. With the brass disc, due to the increased resistance, the effect is not so marked. The iron disc, however, is drawn toward the pole piece,

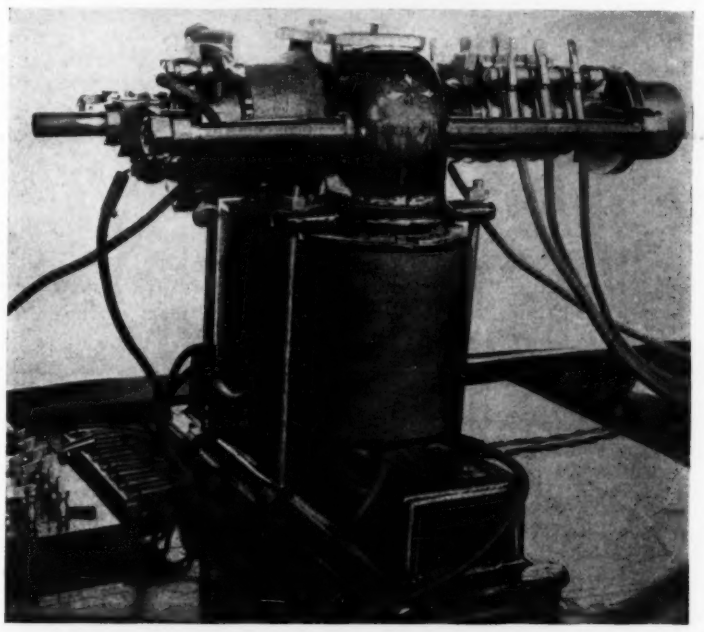


FIG. 9.—TWO-HP ROTARY CONVERTER.

to which it attaches itself. In Fig. 6 a heavy copper ring is shown resting on a plate of glass above the magnet pole. The primary magnetic flux from the magnet and the secondary counter-mag-

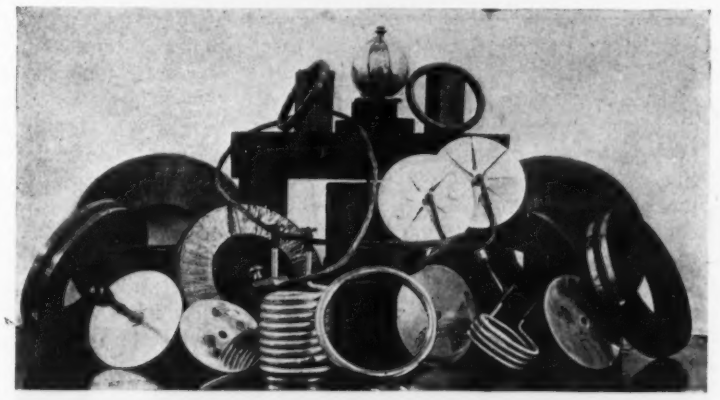


FIG. 10.—ASSEMBLAGE OF APPARATUS.

netic flux set up in the copper ring are well shown by the manner in which the iron filings surround the ring.

Another very interesting experiment with iron filings is illustrated in Fig. 7. Here the polarity of the magnets is the same as shown by the division of the iron filings. Probably the most interesting of the experiments with iron filings is shown in Fig. 8. The peculiar twisting of the magnetic field, as shown by the filings, is due to the current in the coil set vertical on the glass plate. The plane of this coil is at an angle of about 45° with that of the center line of the two pole pieces. Fig. 9 shows the transformer with which the previous experiments were performed, mounted with pole pieces and an armature. This forms a rotary converter of 2-hp, which converts 110-volt, direct current to two or three-phase, alternating current of 25 cycles.

The different pieces of apparatus employed in performing the experiments are shown in Fig. 10. Many other experiments besides those mentioned can be performed by these few simple and substantial pieces of apparatus. The set of experiments as a whole show much care and judgment in their selection and presentation.

Development of the London Electric Underground.

At a moment when New York City's first subway has just gone into operation, it is of interest to note some of the points from the annual report of Mr. Charles T. Yerkes on the underground electric of London.

The power house which will supply the energy for the operation of the Metropolitan District Railway, the Great Northern, Piccadilly & Brompton Railway, the Baker Street & Waterloo Railway, and the Charing Cross, Euston & Hampstead Railway, is nearing completion. Three-quarters of the machinery has been delivered, including two of the turbo-generators, which are now being erected, and it is expected that tests of the machinery will be made during the months of October and November. The boilers and switchboards have been installed, and all the steam and electrical connections have been made. The ducts and cables forming the transmission line to Earl's Court have been laid and connected. It is proposed to take authority to raise $4,250,000 on the security of the power house.

Satisfactory progress has been made in the conversion of the Metropolitan District Railway electrification for operating by electricity, and the principal construction work is nearly finished. In view of the fact that all the work had to be done at night after the regular traffic had ceased, the problem of completing the electrification was made more difficult, and naturally occupied a longer time. All the cable ducts have been laid, the brackets and troughs for the cables on the sides of the tunnels are mostly installed, and a large portion of the cables drawn in and connected. The conductor rails have been laid, the bonding completed. The sub-stations are well advanced and in some cases the machinery installed.

The new rolling stock, made entirely of non-inflammable material, has been ordered, and deliveries are contracted for during the months of November and December. All the electrical equipment for the cars, including the motors and a comprehensive system of control, has been ordered, and deliveries are now being made.

The tunnels between Baker Street and Waterloo Station have been driven, and contracts have been let for the extensions between Baker Street and Edgeware Road, and between Waterloo Station and the Elephant and Castle. The driving of these running tunnels is proceeding rapidly. The construction of the underground stations on the extensions is now in progress; contracts are being let for the surface stations, and the work of laying the permanent way and conductor rails is proceeding. All the rolling stock has been ordered and the electrical equipment provided for. The construction of the car and repair shops at Kennington, Lambeth, is well advanced, and they will be ready to receive the rolling stock when it is delivered.

All the necessary station sites have been acquired for the Great Northern, Piccadilly & Brompton Railway, and the running tunnels driven to the extent of about 80 per cent. of the total length of the line. The construction of the surface stations is proceeding, and the laying of the permanent way and conductor rails will be started in a very short time. By an arrangement which has been entered into by the Metropolitan District Railway, the line will now come to the surface at a point between West Kensington and Hammersmith, which will enable the rolling stock to be taken to the new car sheds at Mill Hill Park to be housed and cleaned. All of the surface station sites on the Charing Cross, Euston & Hampstead Railway have been acquired. About 75 per cent. of the running tunnels has

been driven, and the work of constructing the shafts, cross passages, etc., is well advanced. The land required for the car sheds and repair shops has been secured at Golder's Green, Hampstead, and work on the construction will shortly begin.

The extension from Hammersmith Broadway to Uxbridge Road, via the Askew Road, and the extension from Southall to Uxbridge, have been opened for traffic. These connections admit of a continuous through service between Uxbridge, Southall, Hanwell, Ealing, Acton and Hammersmith, and so afford the residents of the congested portions of the company's system an alternative means of cheap and rapid transit to and from the city and the West End, with interchange facilities between the Metropolitan District Railway and the Great Northern, Piccadilly & Brompton Railway.

Electrical Anniversary at Columbia University.

Columbia University, New York City, has been celebrating the past ten days its one hundred and fiftieth anniversary with appropriate functions and ceremonies. One of the most interesting events of a memorable week—which included the opening of the new Subway and the operation of the first electric locomotive for the New York Central Railroad—was the dinner given to celebrate the fifteenth anniversary of the founding of the electrical engineering department of Columbia University, a date which synchronized with the older one. The dinner was given in the Engineering Building, and was an affair of unusual interest. It was presided over by Prof. F. B. Crocker, who has been at the head of the electrical engineering staff since 1889, and all the arrangements made with much smoothness and efficiency were conducted by Prof. G. F. Sever, adjunct professor, dating back to 1893. The speakers of the evening were Dr. C. F. Chandler, professor of chemistry; Mr. J. W. Lieb, Jr., president of the American Institute of Electrical Engineers; Mr. T. C. Martin, Prof. F. R. Hutton, dean and professor of mechanical engineering; Dr. M. I. Pupin, professor of electro-mechanics; Prof. William Hallock, professor of physics, and Mr. Gano Sellick Dunn, chief engineer of the Crocker-Wheeler Company, graduated in 1891, and so far as known the first from any American University to win the regular E.E. degree. It is needless to say that the speeches were full of reminiscence and anecdotes bearing on the occasion. The proceedings were interspersed with college songs and notably by a lilting ballad entitled, "Columbia E.E's.," composed and conducted by Mr. L. J. Lewinson, assistant professor in the electrical department. Among the large gathering were noted such well-known Columbia men as Prof. R. B. Owens, of McGill University; Prof. Fitzhugh Townsend, Prof. W. H. Freedman, University of Vermont; Prof. F. M. Pedersen, College of the City of New York. These and many other prominent electrical engineers present are graduates of the electrical engineering course at the University, and many of them traveled long distances to participate in the anniversary festivities which were continued during the present week.

Annual Meeting of the Mechanical Engineers.

Prof. F. R. Hutton, secretary of the American Society of Mechanical Engineers, has issued a preliminary notice as to the annual meeting to be held in New York City next December. The new officers nominated are: For president, John R. Freeman, Providence, R. I.; for treasurer, William H. Wiley, New York, N. Y. For vice-presidents—S. M. Vauclain, Philadelphia; H. H. Westinghouse, Pittsburg; Fred W. Taylor, Philadelphia. For managers—George M. Brill, Chicago; Fred J. Miller, New York City; Richard H. Rice, Lynn, Mass.

The headquarters of the society will be as usual at the society house, No. 12 West Thirty-first Street, and the opening session will occur on Tuesday evening, December 6, at 9. President Ambrose Swasey will deliver the annual address, the subject being "The Achievements of the Engineer with Respect to Exact Measurements." The second session will occur on Wednesday morning at the hall of Mendelssohn Union, 113 West Fortieth Street, at 9.30 o'clock. This will be the business session of the convention and the following professional papers will also be presented: "A New Hydraulic Experiment," by Mr. A. F. Nagle; "A Twist Drill Dynamometer," by W. W. Bird and H. P. Fairfield; "Diamond Tools," by Gus C. Henning. Following this luncheon will be served at the society house and the afternoon will be spent in making excursions to various power stations and points of interest.

The third and fourth sessions will take place at Mendelssohn Union Thursday morning and afternoon, respectively. At the morning session the following professional papers will be considered: A. J. Bowie, Jr., "Centrifugal Fans"; Charles T. Main, "Computation of Values of Water Powers and Damages Caused by Diversion of Water Used for Power"; Charles E. Sargent, "An Indicating Steam Meter"; Robert S. Hale, "Stay Bolts, Braces and Flat Surfaces: Rules and Formulæ"; George I. Rockwood, "Condensers for Steam Turbines." At the afternoon session the professional papers will be as follows: "Bursting of Four-Foot Fly-Wheels," by Charles H. Benjamin; "Influence of the Connecting Rod upon Engine Forces," by Sanford A. Moss; "Losses in Non-Conducting Engines," by James B. Stanwood; "Power Plant of Tall Office Buildings," by Stirling H. Bunnell; "Pressures and Temperatures in Free Expansion," by A. Bordody and R. C. Cairncross (presented by Charles E. Lucke). The usual reception for guests and friends will be held at Sherry's on Thursday evening at 9 o'clock and will be followed by dancing and supper.

The closing session will be held at the society house on Friday morning, December 9, at 10 o'clock. Following are the professional papers that will be considered: "Fuel Consumption of Locomotives," by George R. Henderson; "Road Tests of Brooks Passenger Locomotives," by E. A. Hitchcock; "Discharge of Water with Steam from Water Tube Boilers," by A. Bement; "More Exact Method for Determining the Efficiency of Steam Generating Apparatus," by A. Bement; "Forcing Capacity of Fire Tube Boilers," by Francis W. Dean.

The Australian Telegraph System.

Hugh H. Lusk, in the November number of the *North American Review*, describes "The Australian Telegraph System." Before the Australian States were welded into one commonwealth, each of the States owned and controlled the telegraph lines within its borders, but when the union was effected the Federal Government took over all telegraph lines, and the Federal Parliament established the conditions under which they should be operated. Rates were fixed for town and suburban messages, for messages from one point to another point within the same State, and for messages from a place in one State to a place in any other State within the commonwealth, and, taking these together, Mr. Lusk asserts that the cost of telegraphing in Australia is less than one-half, and would probably work out at one-third, the amount charged in America. The combined cheapness and efficiency of the telegraph system in Australia Mr. Lusk attributes to the fact that the telegraph lines are owned and operated by the public, and to the economies naturally attending the system. That the public utilize the facilities thus afforded them for telegraphic communication is evident from the fact that the number of messages per capita in Australia is apparently nearly three times what it is in America. The differences appear due, however, quite largely to methods of counting. He says:

"The circumstances of Australia, and the conditions of its settlement, have had the effect of making both its railroads and its telegraphs unusually extensive in comparison with the numbers of its population, and this is markedly the case with its mileage of telegraph lines. At present the great island is only settled on a strip of country bordering on the coast, and even that strip does not include the more northern shores either on the East or West, and takes in no part of the north side at all. The consequence is that a line of telegraph which connects the settlements of Queensland on the northeast of Australia with those of West Australia on the west coast—a distance, in a direct line, of about 2,500 miles—covers fully double that distance from the necessity of keeping in touch with the settled districts. There is, indeed, one line of telegraph which of necessity ignores this rule, and passes for nearly its whole length of about 1,700 miles from the south to the northwestern corner of the island, through an unsettled country. The purpose of this line is to connect settled Australia with the rest of the world by way of Java and India, and it passes through great districts of the interior, which were first explored for the purpose of its construction. Under the circumstances, it was not possible that telegraph facilities could be supplied in Australia on a small scale, or at a trifling cost."

Tesla On The Subway.

The following letter appears over the signature of Mr. Nikola Tesla in the New York *Sun* of November 1:

"I would not disturb the hymn sung by the press in praise of the Subway had it not occurred to me that just these few fugitive moments of ecstasy offer the best opportunity for pointing out the necessity of its speedy re-equipment. My idea is by no means as odd as it must at first appear to your readers. Permit me to explain.

"Electrical power transmission has been my specialty for many years. After the general adoption of my alternating system of distribution, popularly known as the 'two, three, multi or polyphase,' I turned my attention exclusively to currents of high tension and devised a scheme of artificial insulation of power, permitting an indefinite extension of the distance of transmission and doing away altogether with the loss in the mains. Finally, through a series of improvements, I arrived at my high-potential system, dispensing with wires, in which I have carried the art of electrical energy transmission well toward its highest technical perfection and capacity of application. These inventions, abolishing all barriers to electrical development, will soon sweep the world with irresistible force.

"Naturally enough, I have been intensely interested in the great project, in the city of my home, from its very inception, and have devoted much thought to the best means to employ. The tunnel itself I have never seen and do not know its location. It must be a fine piece of engineering. I am compelled to confess to the same ignorance as regards the power house. The Rapid Transit Company has never asked me for any expert advice or suggestion and I have never been invited to examine any part of the work. It is true that my 'three-phase' system with my 'rotary converters' has been adopted, but it is precisely because of this that a change will be necessary in the near future. This combination of alternating and direct current should not have been employed. It represents the state of the art of more than ten years ago. In the power house three-phase dynamos are installed. The e.m.f. of the currents is raised by 'static transformers.' The high-tension currents operate in each of the sections of the road a 'rotating transformer,' in this case one of my three-phase synchronous motors having its field excited by and generating direct current, which in turn actuates the motors on the cars.

"Now, this plan, while operative, is for a great many reasons objectionable, more so in this particular instance. The Subway problem was peculiar. The length of the circuits was insignificant. The facilities for placing and insulating the mains were great. Financial limitations, which usually hamper an electrical enterprise, did not exist. There was money to burn. The quickness of travel, the safety of the public and of the adjacent property were the dominating requirements. These have not been properly met. A mistake was made in not asking the electric companies to furnish the best instead of the cheapest equipment.

"But it is better to mend late than never. Ignoring the improvements which might be made in the power house, the mains should be insulated artificially by refrigeration. This would save the energy which is now lost in the mains and money besides. More than this, it would insure complete safety against any breakdown of the insulation, which, however, would be self-restorative. The 'rotating transformers,' introducing many elements of incertitude and danger, should be done away with and 'static transformers,' if necessary, installed in the sub-stations. Direct currents, which are a constant menace to life and property, despite subdivision, should be most certainly avoided. Motors of this kind, with their brushes and commutators, sparks, copper dust, nitric acid and what not, are not suitable for so important a thoroughfare, and should be replaced by my 'induction motors' without brushes and commutators, and perfectly free from the innumerable troubles these devices entail. It would be advisable also to employ a greater number of correspondingly smaller motors on each car. This would be, in my opinion, an entirely safe, economical, and in the long run the cheapest apparatus, which could be taxed, without the slightest risk, in the hours of rush, to its utmost capacity, and which, if properly constructed, should last a century.

"To conclude, as I examine the equipment of the Subway, I find that about all to be preserved would be Mr. Belmont's beautiful car, this as a *corpus delicti*. The changes suggested will have to be made sooner or later, and I am quite earnest in recommending an immediate appropriation and commencement of this work of reconstruction without delay, else Philadelphia will have an underground railway several decades ahead of ours."

New Telephone Patents.

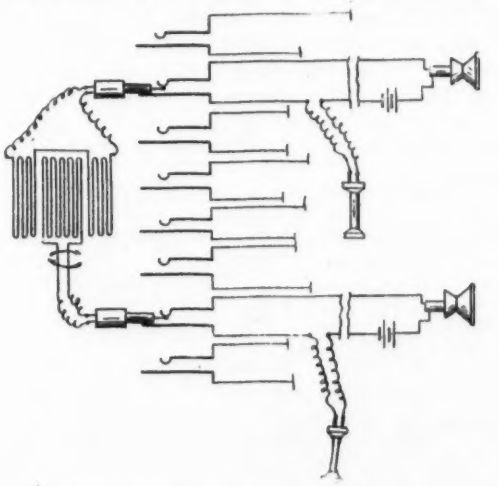
A COIN COLLECTOR.

A new coin collector has recently been patented by Messrs. F. R. McBerty and J. L. McQuarrie. With this collector, while it is impossible to call central without depositing a coin, it is possible to cause the refunding of the coin in case the operator fails to respond. The refund is under partial control of a lever and partially under control of the operator. If the line be busy, when the calling station is on a party line, or if for any other reason the operator fails to respond, the mere depression of the lever serves to return the coin; but if the operator once answers the lever will not refund the coin until the central operator so desires, this being indicated by her disconnection from the line. In case the desired call is accomplished the central operator deposits the coin beyond the reach of the refunding lever, by sending current out over both wires of the subscribers' line in parallel. The coin collector is provided with a target and suitable legend to assist the user in its manipulation. The patent for this collector has been assigned to the Western Electric Company.

Another coin-collecting and toll-counting system, the patent for which has also been assigned to this company, has been invented by Mr. W. W. Dean. In this latter system the deposit of a coin is necessary to call the exchange. The operator answers the call as she would any other and makes up the desired connection. When the desired station responds the relays of the cord circuit operate in combination in such a way as to reverse the current supply toward the subscriber calling in such a way as to prohibit the use of the instrument until the deposit of the coin in the coin box or the registering of a call as the case may be. When the collector or register has been manipulated the circuit connections restore to normal and the instrument becomes useable all without the attention of the exchange operator.

TELEPHONIC REPEATER.

Fig. 1 indicates diagrammatically a novel form of repeater patented by H. Carbonnelle, of Belgium. The grids 12, 12, 12 indicate a peculiar form of alternating-current generator free from iron. The grids are wound upon concentric cylinders and one is stationary and one revolving. The wire traverses each cylinder in a zig-zag, as indicated. The speed of rotation of the revolving cylinder is such that the alternations of the current generated in it, in response to the field action of the stationary grid, are of too high a frequency to effect the telephone *per se*. The average effect of this generated current following the fluctuations of the telephone current in the field grid is a duplicate of the field current and of a relative potential and current depending upon the electrical constants and the speed of rotation.



CARBONNELLE TELEPHONE REPEATER.

MACHINE RINGING KEY.

Several types of machine ringing key have been devised, these keys to continue the ringing of a station automatically after being once depressed until the response of the called subscriber. A patent granted to W. W. Dean and also assigned to the Western Electric

Company, describes such a key. The actuating lever carries an iron armature which is presented to an electromagnet when the lever is depressed. The electromagnet has two windings. One of these is local and is controlled by a contact closed when the lever is depressed. This winding effects the locking of the lever by causing an attraction for the attached armature. The other winding is in series with the alternating ringing supply. The magnetizing effect of this latter coil is immaterial until the subscriber in answering shunts the bell with the low-resistance talking circuit. The rush of alternating current following this is sufficient to demagnetize instantaneously the lock, and allow the lever to restore.

RECEIVER SUPPORT.

Frank W. St. John, of Coshocton, Ohio, has produced a receiver support which includes some novel features. The supporting arm swings in a vertical plane, driving its supporting shaft with it. This shaft carries a notched wheel upon which bears a spring of sufficient strength to hold the receiver at any level at which placed. The telephone circuits are controlled by a switch driven by the shaft. The ringing condition exists when the receiver is turned up out of the way.

MULTIPLE TRANSMITTER MOUTHPIECE.

To avoid the necessity of two persons immediately following each other in the use of a telephone using the same transmitter mouthpiece, a rotary mouthpiece having several bells has been patented by J. S. Ashe, of Philadelphia. With such an arrangement the mouthpieces have good opportunity to air.

CURRENT NEWS AND NOTES.

WIRELESS TO BOSTON.—A special dispatch from Boston says: "It is announced that within sixty days apparatus for wireless telegraphic communication between Boston, Providence, New Haven and New York will be in operation. The American De Forest Wireless Telegraph Company is the projector. G. H. Barbour, its executive engineer, was in Boston recently and closed a contract for the erection of the station. Ocean messages also will be sent and received."

MARCONI STATION AT TABLE HEAD.—It is stated that a new Marconi wireless telegraph station is to be erected at Port Morien, about four miles from Glace Bay, N. S. The present towers at Table Head are to be dismantled. The old power house and operating room are to be removed to the new location, at which new towers, 215 ft. high, are to be erected. The Marconi Company, it is further stated, has purchased 400 acres of land where the new station is to be established, the station to be located in the center of the property.

N. E. L. A.—The National Electric Light Association is about to start an active campaign for new members, and the appointment of Mr. Henry L. Doherty as a committee on membership promises well for its success. The great increase in membership in the past two or three years was largely due to Mr. Doherty's personal efforts and methods suggested by him, and now that he has taken the matter up officially large results may be looked for. At the last meeting three new classes of membership were created, and it is in these classes particularly that the increase is expected. Officers and employes of member-companies are to be received as members, with the written consent of the member company with whom they are connected. The entrance fee for such members will be $5 and the annual dues $5. They will receive the various publications issued by the association throughout the year. College professors and teachers of electrical engineering may become members at a rate of dues of $4 per year, with no entrance fee.

REPULSION-INDUCTION MOTOR.—A patent issued October 18, 1904, to Mr. W. A. Layman, relates to a modified form of self-starting, single-phase induction motor, which differs from that type which starts as a repulsion motor, and is converted into an induction motor after a certain speed has been attained, in that in the new machine the repulsion motor circuits are so arranged as always to be operative. The inventor obtains this result by supplying the armature with two sets of windings, one for the induction and the other for the repulsion motor operation. The latter winding is kept at all times on closed circuit through properly placed brushes, while the former winding is locally short-circuited only when the armature has attained a speed sufficiently high to bring into action a centrifugally-operated mechanism. This construction allows of high torque for starting and gives high power factor under running conditions. A slight modification of connections leads to the use of common conductors for the induction motor and repulsion motor circuits, the results being a diminution of material required and increased losses therein.

THE SARNIA TUNNEL DISASTER.—The Board of Railway Commissioners for Canada is endeavoring to get the railway corporations of the Dominion to agree to certain precautions for the reduction of liability to railway accident. Reference was made by the chairman of the board to the recent disaster in the Grand Trunk tunnel at Sarnia, Ont. The chairman stated that one means of preventing the recurrence of such loss of life was to substitute the use of electric motors for the haulage of trains through this tunnel, and the commission would urge the imperative necessity of this suggestion being adopted by the Grand Trunk Railway Company, which must itself be impressed with the desirability of employing electric instead of steam traction at this point on its system. It will be remembered that a freight train parted in the Sarnia tunnel a few weeks ago and before the parts could be reunited and the train moved out the accumulated coal gas from the engine suffocated six men.

ELECTRIC CLUTCH FOR VARIABLE SPEED.—The torque exerted by an induction motor when running near synchronism varies with the slip and becomes negative when the slip is negative, so that when driven above synchronism such a motor becomes a generator and returns power to the supply system. This feature of the supersynchronously operated induction machine is embodied in an electric clutch, for which a patent was recently issued to N. S. Beam and C. L. Clarke. The rotor of the induction motor is mechanically connected to the rotating shaft of a constant-speed motor, the armature of which is electrically connected to the primary windings of the induction motor, the core of which, being free to revolve, carries with it the shaft to be driven. The rotating field in the primary travels in the same direction that the rotor of the induction motor is driven. The number of poles on the field of the induction machine is double that of the poles on the constant-speed, synchronous motor. A variation in the relative speed of the rotor and the rotating field of the induction motor due to load on the shaft driven by the primary core, causes the machine to act as a generator and return energy to the line. The system is intended particularly for use on a locomotive in connection with a synchronous motor.

A NOVEL SYNCHRONOUS CONVERTER.—An interesting method of connecting in concatenation an induction motor with a synchronous motor or rotary converter, forms the substance of a patent issued October 18 to O. S. Bragstad and J. L. La Cour. The frequency of the current in the secondary of an induction motor varies directly with the slip, and at one-half synchronism it has a value equal to one-half of the circuit frequency. By driving the moving member of a synchronous motor mechanically with the rotor of an induction motor and connecting the secondary windings of the induction motor to the armature of the synchronous machine, the set will synchronize at one-half speed. The inventors propose to use as synchronous motor a rotary converter which can deliver direct current to an external load and to its own field windings. This arrangement allows the converter to be operated at one-half the circuit frequency, which condition of operation is conducive to improved commutation as compared with direct transformer connection to the supply lines, while the machine may readily be placed in use from the alternating-current side. The primary of the induction motor may be wound for the high line e.m.f., thus eliminating the need of additional transformers. In comparison with an induction motor-driven, direct-current generator set, the combination is much less expensive, due to the fact that the motor here required need be of but one-half the capacity of the load, since only this amount of its energy is delivered mechanically, the remainder being given off through transformer action; and also to the fact that a synchronous converter is more economical in material than a direct-current generator of the same output.

WESTERN SOCIETY OF ENGINEERS.—The Electrical Section of the Western Society of Engineers will hold a meeting Friday evening, November 11, 1904, at which Mr. Samuel G. McMeen, consulting telephone engineer, of Chicago, will take up the subject, "Four Interesting Phases of Long-Distance Telephony." On December 9 Charles H. Smoot is on the programme for a paper on the "Regulation of Alternators."

POLYPHASE REPULSION MOTOR.—A patent issued October 25 to M. Milch relates to a motor possessing the characteristics of the polyphase induction motor and the single-phase repulsion motor. The stator winding is similar to that of a two-phase induction motor, while that on the rotor is quite the same as is used with repulsion motors. Upon the commutator of the rotor are placed two sets of brushes, each in locally closed circuit, and each set disposed in the proper repulsion motor position with respect to one phase of the primary winding. When the two repulsion motor torques are in the same direction as the travel of the revolving field due to the stator phases, the machine operates both as a repulsion and as an induction motor, the former predominating at starting and the latter at synchronous speed. The motor may be controlled over wide ranges of speed with high efficiency and torque by varying the voltage impressed upon the primary member.

NEW YORK CENTRAL LOCOMOTIVES.—A telegram from Schenectady of October 27 says: "The big electric locomotive, built by the General Electric Company and the American Locomotive Company as the first of between thirty and fifty designed for use in the New York City terminal and tunnel of the New York Central & Hudson River Railroad, had its first test to-day on a stretch of track at Wyatt's Station, about six miles west of Schenectady. While it is claimed the new locomotive is capable of a speed of 100 miles an hour, no high speeds were attempted to-day. The test was pronounced an entire success. Among those present were Fifth Vice-President W. J. Wilgus, W. K. Vanderbilt, Jr., and E. B. Katte, electrical engineer of the New York Central. The locomotive is built for the heaviest railway passenger service ever handled by electric locomotives. With one of these locomotives, trains of ten or more cars may be hauled at express speed of sixty to seventy miles an hour."

CONSTANT-CURRENT GENERATOR.—In order to maintain the current delivered by series-connected generators at a predetermined value, M. Leblanc, according to two patents issued October 25, proposes to separately excite the generators by a dynamo whose field strength is varied according to the current in the series system. The exciting generator is supplied with field current in a shunt circuit from its own brushes and in an auxiliary circuit from a relay dynamo, the voltage of which varies both in direction and amount according to whether the main line current is greater or less than the normal value. The relay dynamo is excited by current in its field coil, which is connected in circuit with a constant-voltage dynamo and a dynamo whose voltage depends upon the main line current. When the main line current is of normal strength the two dynamos have equal voltages and the relay dynamo receives no field exciting current; but when the line current varies from normal the relay dynamo receives current to cause its e.m.f. to send strengthening or weakening field current to the exciting generator, thus tending to keep the main current constant.

VOLTAGE REGULATOR.—In order that an alternator may maintain a constant voltage under varying loads it is necessary that the field strength be correspondingly varied. In two patents granted October 25, 1904, to M. Leblanc, is described a method by which the field strength may be varied automatically by means wholly electrical. Current for exciting the fields of the alternator is obtained from a combined self and separately excited direct-current generator. The separately exciting field coil of this generator is in circuit with the armatures of a constant-voltage generator and a rotary converter whose voltage varies with the fluctuations of the effective value of the alternating e.m.f. obtained from the main alternating-current generator. If the alternating e.m.f. is normal, corresponding to that set by the constant-voltage, direct-current machine, no current passes to or from the rotary to the auxiliary field coil on the exciting generator. A slight variation in the alternating e.m.f., however, causes the rotary converter and the constant-voltage machine to exchange power by current through the auxiliary field coil, and the direction of this current is such as to tend to keep the alternating e.m.f. at the value set by the constant-voltage generator.

LETTERS TO THE EDITORS.

Suffocation in Railroad Tunnels.

To the Editors of Electrical World and Engineer:

SIRS:—I have been for twenty-five years a specialist in mechanical engineering, and have no particular interest in electrical matters, so that your readers may see that in the statements I hereinafter make I am entirely unbiased. I have read with much interest your editorial of the 15th inst., under the above heading, also your editorial upon the same subject in the issue of October 22.

There is no doubt that every long tunnel is a lasting menace to human life, when traversed by steam locomotives; and one of the gravest cases, if we consider the number of locomotives run, exists here "at home," in the tunnel extending under the eastern division of St. Louis and forming a portion of the approach to the Eads Bridge. This tunnel has already had a number of suffocation accidents, and as long as it is used with the present equipment of steam locomotives, an appalling accident is liable to occur at any moment, by the stalling of a train.

I endorse especially the following editorial remark in your issue of October 22 upon this subject, and am certain that it fits the situation in St. Louis to a nicety:

"There is nothing experimental about the business, and persistence in the use of steam simply means that the management wilfully takes the chance of killing employes and passengers rather than go to the expense of putting in an electrical equipment. We believe the day is coming when no railroad will be permitted to operate in tunnels in any other way than by electricity."

It is with much regret that I thus criticise the management of one of the great institutions of my home city, and especially so in view of the fact that by so doing I am, perhaps, injuring the interests of a number of steam locomotive manufacturers who are my special friends, and in view of the further fact that steam locomotion and steam "automobiling" have been my "hobby" for a number of years. But when it comes to the prevention of suffocation of human beings in tunnels, I am unqualifiedly in favor of electric locomotives, and further believe that I see "the handwriting on the wall" to the almost certain effect that electric locomotives will, in time, displace every steam locomotive.

ST. LOUIS, MO. JOHN C. HIGDON.

The Use of Iron Conduit in Wiring.

To the Editors of Electrical World and Engineer:

SIRS:—I find that rules Nos. 24 and 25 of the National Electrical Code are being disregarded by many inspectors, who allow iron conduit in non-fire-proof buildings in place of glass or porcelain tubes. Rule 24 specifies:

"When from the nature of the case it is impossible to place concealed wiring on non-combustible supports of glass or porcelain, an approved armored cable with single or twin conductors may be used. * * * * * *"

I infer from the above rule that they consider it dangerous to use iron conduits in wooden buildings, as otherwise they would not state that glass or porcelain should be used wherever possible. Some of the inspectors go so far as to recommend using iron conduits in buildings where it is perfectly practicable to use a porcelain tube system.

I have been endeavoring to secure from the National Board of Fire Underwriters a written statement to the effect that they would allow iron conduit in such buildings. Although this request was made over two months ago, it has been ignored. I consider iron conduit in wooden buildings to be dangerous, and think it is well to agitate this question, so that it may be brought up before the National Board meeting this year, in order that the rules can be made clear on this point.

One of the reasons why I consider the iron conduit system dan-

gerous is that it is impossible to thoroughly ground the conduits in the different parts of the building, as it is a farce to suppose that a conduit can be efficiently grounded by mere contact with the fittings, since in most cases it lays loosely in these fittings, and, in many instances, the threads are covered with some kind of insulation. Even if they should be so grounded, it is very doubtful in my mind if they would carry a large volume of current without heating it to a point leading to the ignition of inflammable material.

The electric railways are now having trouble in carrying the current from one rail to the other, although they make contact through the fishplates, etc.; and even after they are bonded they very often have trouble in making a suitable connection between the two rails. As these joints have a great deal more contact surface than the joints in the pipe, it is not likely that they would meet the requirements when there is a large amount of current to be carried.

The inspectors do not seem to expect the wires in conduits to keep up their insulation, because they do not demand as good an insulation test for wires placed in conduits as when non-combustible supports are used. With many iron conduits it is impossible to keep the moisture from condensing inside from time to time, causing the covering to become damp and then dry, which will ruin the insulating qualities of any rubber wire in a few years; also the dampness will cause the pipes to rust inside, which makes it impossible, in a great many instances, to remove and replace the wires.

I have talked with quite a number of representatives of wire manufacturers who make rubber-covered wire, and they confided to me privately that they did not consider rubber wire suitable for iron conduits on account of the moisture condensing in them. Another serious point in using iron conduits in wooden buildings is the danger from electrolysis, as the conduits are liable to carry current to dangerous places.

Those making rules evidently consider wires coming in contact with iron piping as dangerous, because they speak of placing wires at least one inch from it when they are exposed to view, but at the same time do not object to placing the same wires in an iron pipe when they go through a wall, etc. Then they again say that it is very important to have the conduits grounded, but when it comes to a chandelier, where the trouble can easily be detected, then they think it is important to have them insulated.

If they consider that it is safe to have the iron conduits grounded, and they in turn to carry current when the insulation of wires become defective, then why not adopt a system of running one of the wires bare through these conduits, thereby guaranteeing that the pipes are grounded, or if not, answering the same purpose? There could be no objection to this that I can see, for if it is safe for the pipe to carry the current some time, why is it not safe for it to carry it all the time?

It seems that the main objection of the inspectors to the use of the porcelain tube system is that the splicing, tapping, etc., are concealed before they have a chance to examine it, and in many cases they find that joints have been made improperly.

All of these objections can be easily overcome by adopting a rule requiring all wires to be run on the loop system. In this way the inspectors can easily detect poor splices, and at the same time it would make it more easy to locate any trouble in case the wires should become defective.

What is needed more than anything else is a set of rules that the inspectors, engineers and contractors may go by, for the rules that we now have are in many instances inconsistent, or contradict themselves so much that it is impossible to follow them.

From the engineers' standpoint it is very important to get the inspectors to formulate a national set of rules, so that the engineers will know how to specify in what manner the work should be done in the different parts of the country, instead of trying to meet the views of the different inspectors with whom they come in contact.

The Underwriters' inspectors cannot follow their rules, but still they are barred from making their own (in writing). Therefore, all the engineer has to go by is their oral permission, which is liable to be changed at any time a new inspector is appointed.

Baltimore, Md. G. E. Painter.

DIGEST
OF
CURRENT ELECTRICAL LITERATURE.

Dynamos, Motors and Transformers.

Distortion of the Voltage Curve in Alternators.—Bauch.—A communication putting forward some critical remarks on the paper of Wangemann, which was recently abstracted in the Digest. The writer considers that at no load the distortion of the e.m.f. of a dynamo is due to two causes: First, to the change of the flux density in the teeth, the distortion being the greater the smaller the number of teeth and the higher the saturation of the magnet system; secondly, to a change of the total number of lines of magnetic induction, which is the greater the smaller the number of teeth and the smaller the saturation of the machine outside of the teeth. If the alternator generates current, the load being non-inductive, the voltage curve is distorted on account of armature reaction and the current curve is distorted for the same reason in the same way. If the circuit contains a constant self-induction, the current curve approximates the sine form, while the voltage curve also becomes generally more sinusoidal and its maximum decreases nearly always below the value at no load. If the circuit contains capacity the current and voltage curves are distorted and the average value of the voltage is higher than at no load at the same excitation. If the circuit contains neither self-induction nor capacity, the average value of e.m.f. is smaller than at no load with the same excitation, while the maximum may be greater or smaller, according to the machine; only in rare exceptional cases it equals the value at no load.—*Elek. Zeit.*, October 13.

Capacity in the Secondary of a Transformer.—Lichtenstein.—An account of experiments made with a transformer, the secondary of which consisted of two windings, each of 30,000 turns, which could be connected either in parallel or series. The ratio of voltages was correspondingly 1 to 1,000, or 1 to 2,000. It was found that with open-secondary circuit and with constant-primary voltage, the primary current was different when the two secondary windings were connected in parallel or in series. The primary current when a pole of the secondary winding was connected to earth also differed from the value when both poles were insulated. The difference in the values of the current amounted up to 50 per cent. They are explained by the fact that the secondary circuit, which consists of a very large number of single windings, has considerable capacity. This causes charging currents to be produced secondarily at open circuit, their intensity differing according to the connections; they react upon the primary current. The correctness of this explanation was proven by directly measuring the secondary charging current. The conditions are explained with the aid of diagrams. It is thus shown that transformers having a high capacity may easily develop electric oscillations. From this the comparatively frequent occurrence of high voltages during insulation tests may be explained.—*Elek. Zeit.*, October 6.

References.

Equipotential Connections.—Lionville.—An article, illustrated by diagrams, on the fundamental principles of the equipotential connections of Mordey and others in dynamo armatures.—*L'Industrie Elec.*, September 25.

Induction Motors.—Benischke.—A mathematical article on the theory of induction motors. The magnetic stray field is of great importance since the maximum power factor depends mainly on it. Moreover, the circular diagram of the induction motor is determined by the stray field and the magnetization current. For this reason the calculation of the stray field is important. Several formulæ have been given containing empirical constants which, however, always refer to certain forms of the slots. The author shows that the calculation of the stray field can be made with greater accuracy if the magnetic reluctances are calculated from the geometric and

magnetic conditions of the motor. It is then also easy to find the magnetization current.—*Elek. Zeit.*, September 22.

Single-Phase Induction Motor.—MÜLLER.—An article illustrated by diagrams, on the theory of the single-phase induction motor. He shows that the self-induction in the rotor circuit does not depend upon the slip, while in polyphase motors it decreases with the slip, it maintains the value which it had at rest for any speed in the single-phase motor. This result is discussed and it is shown that in the single-phase motor the e.m.f. induced in the rotor leads before that in the stator. He shows how to calculate the stator current, the rotor current, the magnetization current in the main phase and the magnetization current in the cross phase.—*Elek. Zeit.*, September 29.

LIGHTS AND LIGHTING.

Nernst Lamp.—GAISBERG.—An account of tests of Nernst lamps in Hamburg. Lamps for 0.25 and 0.5 amp. were tested, both types at 110 volts, of which 95 volts were consumed in the filaments and 15 volts in the series resistance. During the tests the lamps were twice disconnected in 24 hours from the circuit and lighted again after they got cold. The results are given in the following table, in which the candle-power is measured in the direction of the axis of the lamp:

After (hours)	0	25	50	100	500	700
0.25 amp.: watts	30.7	29.8	30.5	29.5	27.1	21.5
C. p.	19.7	14.4	12.3	12.6	10.5	6.2
Watts per c. p.	1.6	2.1	2.5	2.3	2.6	3.5
0.50 amp.: watts	57.4	57.4	55.8	55.5	53.1	42.7
C. p.	44.4	29.7	28.7	27.7	24.4	14.4
watts per c. p.	1.3	1.9	1.9	2.0	2.2	3.0

The table shows that the candle-power of the lamps decreases considerably during the first hours, and remains then nearly constant for some time, but decreases greatly again afterward. Compared with the candle-power after 25 hours, the 0.25-amp. lamp shows a decrease of candle-power of 15 per cent. after 300 hours, and the 0.5-amp. lamp a decrease of 20 per cent. after 500 hours; 300 and 500 hours are considered the normal life for these two types, respectively. Tests were made of older types of Nernst lamps in practical use for lighting a public promenade, the filaments being operated at 200 volts and a series resistance consuming 20 volts. The watts per candle-power were in the beginning 1.2 to 1.3 and after 300 to 400 hours 1.7.—*Elek. Zeit.*, October 13.

POWER.

Electric Hauling Machines.—KOCH AND SCHMIEDE.—A long article on the calculation of electrically-operated hauling machines for mines. They first give a summary of those data which must be known for the calculation and then give rules for carrying out the calculation. They prefer the use of direct current under any circumstances, while for the operation of pumps, air compressors, etc., three-phase current may be better. For speed regulation, the direct-current dynamo which generates the current and the hauling motor are separately excited and the regulation of the motor is accomplished by varying the excitation of the dynamo. Another means is to use a booster whose voltage may be added or subtracted from that of the network. In this case the system is operated in connection with a storage battery. The connections for these systems are diagrammatically shown. Their method of calculating the hauling machine is based on certain assumptions how the control is to be accomplished. The authors describe a device by which the attendant is forced to operate the controller in just that way on which the calculation is based.—*Elek. Zeit.*, September 22.

Manufacturing Plant.—An illustrated description of the new electric manufacturing works of Schneider & Co., at Champagne, on the Seine, France. Electric energy is distributed by the three-wire system with 440 volts between the outers. The incandescent arc lamps in groups of six in series also at 220 volts. All motors with a capacity above 3 kw work at 440 volts; those of smaller capacity at 220 volts. There is a storage battery of 250 cells with a capacity of 800 amp.-hours for a five-hour discharge. The average power absorbed in the works is 93.275 kw. All machine tools consuming more than 0.75 kw are driven by individual motors. The smaller machine tools are operated in groups from shafts of 5 meters length, each shaft being driven by a motor. The cables of the distribution network are of aluminum.—*L'Industrie Elec.*, September 25.

Steam Turbine.—An article on the Hamilton-Holzworth steam turbine which, like the Parsons, has a large number of stationary discs and running wheels, but while the Parsons expands in both stationary blades and running wheels this turbine expands only in the stationary blades. The radial height of the vanes in these is gradually increased from high to low pressure, corresponding to the volume to which the steam expands in its course. The turbine is built only with horizontal shafts.—*St. R'y Jour.*, October 8.

TRACTION.

Methods of Dealing with Mixed Systems of Traction.—FELL.—An abstract of a British Municipal Tramways Association paper, the greater part of which dealt with the problem which faces the tramway engineer during the reconstruction of the line for electric traction. On the London County Council system the roads have been kept open for vehicular traffic in the majority of cases, and the tramways have, with two exceptions, been kept running on a temporary track at the side of the road. During the reconstruction period horse, cable and electric traction were used simultaneously, although while the Brixton cable section itself was being converted this portion of the line had to be closed. It was not found feasible to haul the electric cars by cable over this section owing to their weight. After reconstruction the receipts on the Brixton part of the route were doubled and the completion of the through route increased by 25 per cent. the receipts on the other portions of the electrically-equipped line from Westminster and Blackfriars to Brixton. The cost of combined horse and cable traction on this whole route had been 19.98 cents per car-mile; "mixed" electric, horse and cable traction, 15.84 cents, and electric traction alone 14 cents. The author anticipates that this will be reduced to 12 cents when the permanent generating station at Greenwich is opened. Some of the new electric lines will be on the trolley system and no difficulty will be experienced in working these in conjunction with the present conduit system. The author considers the latter system the ideal one for London, however. A shallow tunnel 13 ft. high is being constructed between Southampton Street and the Victoria Embankment. In the discussion Snell said that, on the whole, closing the road for vehicular traffic during reconstruction is the best plan, and the work can then be finished quicker.—Lond. *Elec.*, September 30.

New York Central & Hudson River Railroad.—WILGUS.—An article on the electrification of this road. The writer describes the conditions at present on that line and the reasons for adopting electricity. The new locomotives will be of 2,200 hp and will weigh 85 tons, of which 67 tons will be borne on four pairs of drivers. The heaviest steam locomotive of the company weighs 150 tons, of which 47 tons are on the drivers. This gives the electric locomotive 25 per cent. greater weight available for platforms, with 43 per cent. less dead weight. The size and exact character of the suburban cars have not yet been settled.—*St. R'y Jour.*, October 8.

Economy in Consumption of Current.—FISHER.—A paper presented to the British Municipal Tramways Association. It is suggested that when current is purchased from another department three meters should be used in series and the average of the readings taken; if one meter varies 3 to 5 per cent. from the others it is taken out and recalibrated. Considerable difference of opinion exists among tramway managers as to cross-bonding the overhead work as an assistance to the maintenance of constant pressure. Cross-bonding is thought to be desirable on hilly routes, at all events at the grades themselves, while the disadvantage is that both the up and down lines are put out of service over a half mile section between feeder pillars if there is a short-circuit on either line. In Glasgow the overhead work is cross-bonded at one or more points in each section. At Blackburn a bonus system for motormen has been introduced. An average of 1.87 B.T.U. per car-mile has been taken as the basis of what should be the consumption, and, for every tenth of a B.T.U. below this figure, 25 cents per week is added to the wages of each motorman. Car wattmeters have so far been used with little success in most places, the prevalent opinion being that they are unreliable. In the discussion of the paper several speakers doubted if the amount paid away in bonuses would not be greater than the value of energy saved. Moreover, it would not be feasible to judge each motorman simply from the consumption of energy, since the condition of the rails and the regularity of the voltage make considerable difference. Giles, of Blackburn, explained that his bonus was paid to all motormen, the total units consumed being divided by the total car-mileage. He found that the curve fluctuated considerably with the weather.—Lond. *Elec.*, September 30.

REFERENCES.

St. Louis.—HOBEIN.—An article on a new central sub-station of the St. Louis Transit Company. It contains seven 1,000-kw rotary

converters and a 5,000-amp.-hour, 600-volt storage battery. The foundations are entirely of concrete. The battery floors are filled with brick grouted and covered with pitch. Air is blown into the chamber containing the transformers, high-tension bus-bar compartment, etc., and this air subsequently passes through the battery room.—*St. R'y Jour.*, October 8.

Pacific Coast.—WILCUTT.—An article on the development of electric traction on the Pacific Coast. Cable power was developed in San Francisco owing to the steep grades and was kept in use for a long time for this reason. In 1896 over 77 miles of electric track had been built in San Francisco, and at present there are over 186 miles of track in that city. Single-truck cars were originally in favor owing to the steep grades, but double-truck cars are now in use.—*St. R'y Jour.*, October 8.

Trolley Wire on Curves.—HUTH.—A communication with reference to the recent article of Wahle. For placing the trolley wire on curves of the track, not the central line between two rails is to be followed, but the significant line is the curve made by the center point of the car roof around which the trolley arm turns. Wahle considers it to be suitable to place the trolley wire not perpendicularly above the central line between the two wires, but to go somewhat inward toward the curb. This has always been done in practice by various companies.—*Elek. Zeit.*, September 29.

Wear and Tear of Trolley Wire.—An illustrated description of an apparatus for measuring and registering the wear and tear of the trolley wire.—*Elec. Zeit.*, September 29.

Third Rail.—A correction of the statement that the New York, New Haven & Hartford Steam Railroad Company had taken up the electric third rail on one of its branches because of dissatisfaction with electric operation. This action was due to the fact that the former heavy summer traffic on this line had ceased, as the hotels had been abandoned to make way for the construction of a public park. The writer then explains why local conditions made it necessary to place the third rail in the center of the track.—*St. R'y Jour.*, October 15.

History of Electric Traction.—A large number of historical articles, especially on early traction experiments, are published in the Souvenir issue of the *St. R'y Jour.*, October 8.

Tramway Accounts.—The standard form of municipal tramway accounts, recently adopted by the Municipal Tramways Association, is published in Lond. *Elec.*, September 30.

INSTALLATIONS, SYSTEMS AND APPLIANCES.

Resonance in Three-Phase Cables.—HUMANN.—An article illustrated by diagrams in which the author shows that very considerable increases of voltage may occur in three-phase cables if in a line between a generator and an unloaded transformer one conductor of the three-phase cable is disconnected at the one end and another conductor at the other end. This is shown in Fig. 1, where I, II, III

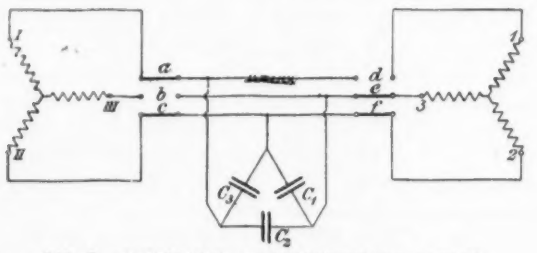


FIG. 1.—RESONANCE IN THREE-PHASE CABLES.

represent a three-phase generator and 1, 2, 3 the primary of a transformer, which is not loaded. The connections, *b* and *d*, are broken. C_1, C_2, C_3 represent the capacities of the conductors of the cables against each other. Under these conditions, a closed circuit exists

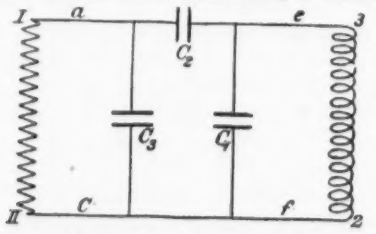


FIG. 2.—RESONANCE IN THREE-PHASE CABLES.

which is diagrammatically shown in Fig. 2 in which the letters have the same meaning as in the preceding figure. It will be seen that resonance is possible. The author formed such a circuit of three mica condensers and an induction coil containing iron (2, 3), while I, II represent an alternating voltage of 14 volts. C_1, C_2, C_3 were each equal to one microfarad. The impedance of the induction coil was 1,310 ohms, the ohmic resistance 164 ohms, and the self-induction 3.4 henrys. Sinusoidal current of 61 periods was used. At the terminals of the condenser, C_3, the voltage was 14; at those of C_2 it was 126, and at C_1 it was 120. Thus there is at C_2 a voltage nine times higher than at the generator. He shows that the same danger exists if the capacity of the cable is not represented by three condensers in delta connection, but by three condensers in star connection. He recommends to use in high-voltage plants or lines no fuses whatever, but only automatic interrupters acting in oil, by which all three phases are simultaneously broken.—*Elec. Zeit.*, October 13.

Regulation of Voltage in Distribution Networks.—MÜLLENDORFF.—A discussion of how to meet the great variations of voltage at different feeding points of a distributing network. These differences in voltage are especially great when the network is not too extended, the feeding points in an industrial center, in residential sections, in theatre districts, etc., having a maximum load at very different times. The author discusses the method in which the feeder to those points, the momentary low load of which is to be compensated for, is dissolved into a number of parallel conductors, each of which can be disconnected separately. For instance, if the feeding point, 1, has at the time only 1 *n*th of its normal load, while point 2 has full load, then the cross-section of feeder 1 is to be divided into *n* equal parts. For 1 *n*th normal load, the resistance of the feeder is to be made *n* times greater (by disconnecting *n*-1 of the *n* conductors in which it is dissolved); in this case both feeder points are then still equipotential.—*Elek. Zeit.*, October 6.

REFERENCES.

Use of Booster.—ITTERSUM.—A communication recommending to use a booster not only for increasing the voltage for the charge of the battery, but also for increasing the discharge voltage in such a way that the voltage of the battery is brought to the e.m.f. required for the bus-bars. This has the advantage that the number of storage cells is reduced; that a smaller cell switch is required; that the cells are utilized in a more rational way, and that the regulation is more exact. The proposal is illustrated by an example. In an editorial note it is said that this proposal is not new. There are several central stations in England which use the automatic reversible booster system without any cell switch, so that the regulation of the voltage is accomplished completely by the booster.—*Elek. Zeit.*, September 29.

Lightning Arresters.—An illustrated description of the lightning arresters of Renous and of Schneider & Co.—*La Revue Elec.*, October 15.

WIRES, WIRING AND CONDUITS.

Cable Tests.—An illustrated note on tests of three-core cables made with paper insulation for a normal voltage of 11,000. The cross-section of each conductor is 195 mm.^{2}. The insulation thickness of each single core is 11 mm. and that of all three cores against the lead again 11 mm.; the external diameter is 72 mm. It was specified that any piece of the cable should be capable of being bent in form of a circle of a diameter five times the external cable diameter and should then stand a testing voltage of 33,000. In this test the three conductors were supplied with current, while the lead sheathing was connected with earth. The cable stood a voltage of 90,000. The paper which is used for insulation is impregnated with a mass containing a higher content of viscid oil than usual, so that the cable is very flexible even at lower temperatures. The higher content of oil, however, diminishes the insulation resistance, since it is a general property of oils to have a relatively low specific insulation resistance. The perforation voltage of such an impregnated cable, however, does not decrease with increase of the content of oil; it rather increases. It is said that the perforation voltage is the principal factor which determines the quality of a cable, and it is pointed out that insulation resistance and perforation voltage are entirely independent of each other, so that it is possible that a cable with high insulation resistance may break down at a relatively low voltage, while cables with a low insulation resistance may have a very high perforation voltage.—*Elek. Zeit.*, September 22.

ELECTRO-PHYSICS AND MAGNETISM.

Spark Length in Atmospheric Air.—WALTER.—For dielectric substances Baur has proposed the rule $v = c\, d^{2\cdot3}$, where v is the perforation voltage, d the perforated thickness of the substance and c

a constant. The present author remarks that this is only an empirical rule and no law of nature. This is shown, for instance, by the fact that for air another rule is valid, namely, the linear formula, $v = a + b\,d$. Here a is approximately 17,000 and b 350. This formula holds good for spark lengths between 5 and 380 mm. It cannot hold good for smaller spark lengths, since when d gets smaller and smaller, v must approximate the value zero and not 17,000, as would follow from the above formula. To explain this the author points out that when an electric spark goes over in air two factors are to be taken into account, one of which is the so-called transition resistance at the electrodes and the other factor the resistance of air between them. To start a spark there is always necessary, for any spark length, a constant minimum value of the ionization current of air.—*Elek. Zeit.*, October 6.

Magnetic Change of Length in Hensler's Alloy.—AUSTIN.—An account of a further investigation of the properties of Hensler's magnetic alloy made of non-magnetic metals (manganese, copper, aluminum). He studied its behavior in a magnetic field and found an extension on magnetization in two different specimens, the extension being nearly proportional to the magnetization. The curve of extension is similar in shape to the curve of magnetization, but it rises more slowly. In strong fields there is a contraction which, however, takes time to develop; it appears to be proportional to the square of the field intensity.—*Verh. Deut. Phys. Ges.*, VI, No. 14, 1904; abstracted in Lond. *Elec.*, September 30.

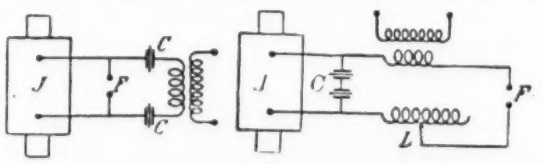
ELECTRO-CHEMISTRY AND BATTERIES.

Zinc.—HESS.—A summary of processes patented and described during recent years concerning the electrometallurgy of zinc. He first deals with processes using electrolysis of aqueous solutions or fused salts and then deals with the use of the electric furnace. The employment of the latter he believes to be promising, since the heat can be better utilized in it than in the ordinary metallurgical zinc process. The trouble is in various processes that the zinc is obtained in powdered form. This is due to the dilution of the zinc vapors by CO, resulting from the reduction of the zinc ore. For this reason the ore should be reduced before the zinc distillation, and the CO resulting from the reduction should be prevented to come into the distillation furnace. The De Laval process is in use in Norway, 2,400 hp being used; but no zinc ore is reduced there, but only spelter is refined. The refined zinc is 99.9 per cent. pure.—*Zeit. f. Elektrochemie*, September 2, 23.

Electrolysis of Acid Solutions of Aniline.—GILCHRIST.—When hydrochloric acid is electrolyzed, chlorine is set free at the anode and it would seem possible to dissolve a little aniline in the acid and let it be converted into chlor-aniline by the chlorine set free. However, aniline black is formed, if the experiment is made. Its formation from 0.1 normal aniline in solutions of n-hydrochloric acid or n-sulphuric acid takes place at 0.95 volt. Therefore, only traces of chlor-aniline are formed on electrolysis of aniline in hydrochloric acid solution; but brom-anilines are formed by the electrolysis of solutions containing hydrobromic acid and aniline.—*Jour. Phys. Chem.*, November.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Tesla Transformers.—MASLER.—An article in which he calls attention to the fact that only for a certain value of the capacity, C, in the arrangement shown in Fig. 3, an active brush discharge occurs



FIGS. 3 AND 4.—TESLA TRANSFORMERS.

at poles of the secondary coil if the spark-gap, F, is fed from the induction coil, J. There must be resonance between the secondary winding and the closed oscillation circuit of the Leyden jars. It is somewhat difficult to find experimentally the correct capacity, C. The author prefers the following arrangement: He chooses a condenser, C, of not too large a capacity, or two Leyden jars in series, which are connected in parallel with the terminals of the induction coil, J, as shown in Fig. 4. L is an adjustable self-induction, made of a varnished wooden drum of about 30 cm. diameter and 40 cm. length, on which about 20 turns of bare copper wire (2 mm. diameter) are wound. Connection is made by a sliding contact. F is a spark-gap. At the beginning of the experiment the whole self-induction is inserted, which is then gradually diminished by slowly revolving the drum, until the discharge at the secondary terminals of the transformer occurs.—*Elek. Zeit.*, September 29.

REFERENCES.

Measuring Wire and Compensator.—SCHÜPPEL.—An illustrated description of a measuring wire and compensator devised by Thiermann, in which the combination of resistances enables one to make all direct-current measurements in the simplest way and with the greatest accuracy (six digits without interpolation). If in practice such an accuracy is not wanted, a number of larger resistances and contacts are left out. The arrangement is so made that the resistance of a contact is added in the worst case to 100 ohms, so that it cannot cause any appreciable error in the result. The Weston cell is considered to be preferable in all cases to the Clark cell. The author first describes in detail the arrangements of the single measuring wire, then a double wire with a standard cell for compensation purposes; then devices for increasing, diminishing and in general regulating the voltage; then a device for regulating the galvanometer current and finally the complete compensator. The article is illustrated by a great many drawings which show the arrangements in detail.—*Elek. Zeit.*, September 29.

Applications of Oscillograph.—WITTMANN.—An article illustrated by diagrams describing some methods of applying the oscillograph for the following purposes: First, to investigate and plot current curves, especially curves of electromagnetic oscillations and their superposition; also alternating-current curves; secondly, magnetization curves; thirdly, to plot curves of cyclic magnetization process.—*Elek. Zeit.*, October 13.

Power Factor Meter.—An article describing a test of a two-phase power factor meter, with a diagram showing the connections. The method for correcting for changes of frequency in power factor meters is described.—*Elec. Club Jour.*, October.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Storage Batteries in Telephony.—BRÜCKMANN.—While the introduction of the storage battery offers no difficulty in telephone exchanges, it has distinct disadvantages when installed at the subscriber's house because the battery is then discharged only at long intervals with very small currents. It is practically at a condition of rest, which is not advantageous since it promotes self-discharges and sulphatization. Results are given which were obtained with various batteries of German manufacturers. While in the first years of their installation, their cost of maintenance was less than for dry cells, it became higher later on. It was, therefore, decided to install no more storage cells at subscribers' houses. Of course, the situation is entirely different for central battery systems.—*Elek. Zeit.*, September 22.

Block Signals.—An article on improvements in block signal systems for single-track railways. The principal feature of the system is that any number of cars may enter a block, as the danger signal remains set until the last car is out. This is effected by the use of a ratchet arrangement in the controlling mechanism. Each car as it enters moves the ratchet one notch, and as it leaves sets back the ratchet one notch. When the last car is out the signals return to safety. A plan of the wiring arrangement is given and also an illustration of the controller.—*St. R'y Jour.*, October 7.

REFERENCE.

Telephony.—PALMER.—An article giving a general summary of the fundamental principles of telephony, especially of the transmission line.—*The Rose Technic*, October.

MISCELLANEOUS.

REFERENCE.

Steel.—CAMPBELL.—A paper on the influence of carbon, phosphorus, manganese and sulphur on the tensile strength of open hearth steel. The author gives empirical formulas for the tensile strength as function of the amounts of the addition.—*Iron Age*, October 27.

New Book.

THE METRIC FALLACY. By Frederick A. Halsey. The Metric Failure in the Textile Industry. By Samuel S. Dale. New York: D. Van Nostrand Company. 231 pages. Price, $1.00.

A certain venerable astronomer, whom the writer is honored in reckoning as a friend, reserves the upper right-hand corner of his tallest bookcase for certain varied works which may best be described as the apocrypha of science. The immortal Symmes is there, side by side with the treatises of voluble gentlemen who maintain that the earth cannot be hollow, because it is flat; General Pleasanton's blue glass book rests peacefully by a tome on the Kaballa. Even the soberest pamphlet in the collection connotes "wheels." Now, when an alleged argument starts off on a fresh chapter by the statement that "every thinking man knows" that a duodecimal system of numbers would be better than the present decimal system, one realizes, quite apart from the truth or falsity of the statement, the exact intellectual status of the book in question; and by that same evidence it will shortly be consigned to its proper company. It will occupy, however, a place unique even in that weird collection, for no one of its neighbors, under whatever obsession written, can properly be stigmatized as deliberately misleading, and such a table of reputed non-metric units used in metric countries as Mr. Halsey recites can be fairly characterized in no other way.

Either the ordinary idea of parcel measurement has not yet penetrated his mental integuments or he has ignored it with intent to deceive. Why did he forget to cite the sale of bacon by the strip and of cabbages by the head? As a matter of fact, articles of commerce in all countries are made up in various sorts of packages for transportation or sale. The size of these packages is fixed roughly by usage or convenience, and usually bears no general relation to the metric or any other system of exact measurement. Even in the commonest use of these packages their real content is expressed for actual sales in the proper units. For instance, one buys a "tub" of butter or a "bale" of cotton, but the actual payment is based on net pounds. Similarly, a German buys a "fass" of beer or a "pfund" of tobacco. In the former case the "fass" is invoiced by its real contents in liters, and in the latter he actually gets 500 grams, whichever one of Mr. Halsey's beautiful list of pounds he expects. In other words, the surviving non-metric names in metric countries are, with rare exceptions, either the conventional names of packages invoiced at their real metric values or vernacular names for particular metric values.

A few ancient units really survive as part of the useless impedimenta of various trades. For example, the Paris "ligne" still occasionally figures in French opticians' catalogues; the avoirdupois drachm, of our sacrosanct English system, finds its last refuge in weighing out powder for cartridges; and gems—save pearls, which are usually sold by the grain—are still solemnly weighed out in carats. And right here let the writer call Mr. Halsey's serious attention to a point so exactly in accord with his conception of proper weights and measures that he should secure its adoption by the A. S. M. E. The merchant of gems scorns decimals and condemns even ordinary vulgar fractions, and writes down a diamond as weighing two carats, an eighth and a sixteenth. And while he is about it, Mr. Halsey should start a propaganda for the preservation of the barley-corn, that precious old subdivision of the inch which is the birthright of all English-speaking folk, and of which they have been cruelly robbed in these later days of degeneracy.

Old weights and measures cling for a while, but there is little need to worry about them, for they will fade out of use spontaneously if they come into competition with the metric system. Old gentlemen will speak of rods or of scruples just as they wear long boots and stocks, without any material effect on the growing world. Ancient units cling most firmly in regions where general education is at a low ebb, or in the nomenclature of particular trades, but as a whole they slip out of use from their very inconvenience. The line and the barley-corn, the stone and the hundred-weight, are evanescent or obsolete, the furlong and the rod are fast passing out of use, and the rest of our horrible heterogeneous mixture will rapidly follow them toward oblivion as soon as the metric system becomes practically known in this country as a commercial system.

The question at issue is merely whether we shall constantly be burdened and vexed with a great mass of heterogeneous weights and measures or shall adopt, like most other civilized countries, a simple and convenient international system. Our present abomination is a relic of the mediæval times, when each country, province, trade and business, had a crude and purposeless set of measures of its own.

Mr. Halsey makes much noise over "scientific" as against "industrial" measurements. It is a distinction without a difference when precision is of any consequence. The grocer spills sugar into the scale pan until it is somewhere nearly balanced and lets it go at that, whether it is a pound here or 500 grams in Germany, and he can use the metric weights as easily as any other. The carpenter lays out his work to a pencil mark and saws somewhere near it, whether in inches or centimeters. But wherever precise work is required, as in much machine work, the industrial measurement must be made with scientific care on whatever system it is based. In working to templets and gauges, the workman must use extreme care, independent of the system, and in much exact work it has been found necessary to work in fine decimals of an inch. The result of Mr. Halsey's beautiful distinction in practice is that "industrial measurements" are commonly merely inexact ones. Pipes and rods, even screws and bolts, are true to their alleged gauge only in round numbers, which may or may not give the required degree of exactness. Pipes are notoriously not of their listed dimensions, and their commercial sizes could be given in round numbers of millimeters just as well as in incorrect fractions of an inch. Our learned author falls easily into the error, common among those who are dismally ignorant of the metric system in practice, of supposing that because the relation between inches and meters is numerically complex when exactness is necessary, all metric measurements must be carried out with finical details. On the contrary, the metric units lend themselves quite as simply as any other to the rough-and-ready measurements of common life. For exact purposes the binary subdivisions of the inch are notoriously insufficient and those of the pound (which one?) are worse, while the metric units are exceedingly convenient.

It is a very gross error, too, to suppose that the metric system is difficult to learn or to apply. The strictly decimal relation of the units makes it easy to work with, and any intelligent lad can get to thinking in centimeters and liters and kilograms with wonderfully little practice, and the moment the metric system is taught in the schools as a living thing, it will fall easily and naturally into line as the only system seriously worth considering. Mr. Halsey fairly paws the air at the imaginary difficulties of the change. He views the subject in the attitude of the petty repair shop metal bungler, who has one sacred micrometer caliper carefully preserved in a locked drawer, and directs his "industrial measurements" with a greasy two-foot rule of uncertain origin; who makes a pin "an eighth, full" or "a quarter, scant" and waggles his die to "ease the thread." The real difficulties can hardly be regarded as formidable by any one who knows both the metric system and the methods of industrial establishments. Once the engineers and the toolmakers get into line for metric measurements, the rest of the force follows almost automatically. And as the aforesaid two classes are composed of intelligent men, the change will be easy for them. In point of fact, within these classes, and also among draughtsmen, a considerable proportion, perhaps the majority, is, from previous education abroad or here, already pretty well used to the metric system. The machinist in general is deft and capable, and to insinuate that he will be perpetually muddled by changing from one set of measures to another is an insult to his intelligence.

The proposals now on hand for the adoption of the metric system in this country are of the simplest possible description. They merely render its use obligatory after a certain period in Government transactions. On this simple foundation the small but noisy band of antimetric freaks which Mr. Halsey so fitly represents, has built up a hypothetical structure of Governmental coercion and restriction of personal liberty, which reminds one of the hysterical outbursts of aggrieved swindlers and paranoiacs against pure food laws and quarantine regulations. Under the proposed law it is a matter of profound indifference to the general public whether Mr. Halsey and his crew of kickers use the metric system or not. They can measure length in Chinese chiks and weights in Javanese catties if they like, but in dealing with Uncle Sam they will have to adapt their heathen units to the simple system employed by most other civilized governments. They seem to be greatly grieved at the "confusion" which they suppose this simple provision will create, but if they had a well-grounded belief in the soundness of their own contentions, they could well afford to smile in superior wisdom and let the object of their aversion fall of its own weight. They must know in their inmost hearts, however, that if the point of the metric wedge

is once entered, the whole gnarled log of our present shapeless burden will soon be split up for firewood. The same sort of frenzied objections were raised a few years since when standard time was substituted for local time, and with about as much reason. Mr. Halsey and his friends would do well to emigrate to Eastport, Me., where their obsession of diversity would be glorified by three different kinds of time.

As an appropriate snapper to Mr. Halsey's penny whip comes a gifted gentleman named Dale, who, in the words of the lamented Josh Billings, "knows a hull lot uv things that ain't so," about the application of the metric system to textile manufactures. The intellectual scope of his arguments is beautifully exemplified by the following *verbatim* quotation (p. 146): "The width in the loom was given in units of 4 in. (decigrams) although the centigram (4/10 of an inch) is too long for expressing woven widths." Further comment on Mr. Dale's exhaustive metric researches would seem to be superfluous.

BROOKLINE, MASS. LOUIS BELL.

THE METRIC SYSTEM IN GERMANY.

To an engineer carrying on his profession on the European Continent this book is a revelation; not a revelation of technical facts, but of the frame of mind of the authors. The book is liberally sprinkled with Shakespearean quotations and hence I am tempted to add one more to describe its tenor. It is "full of sound and fury" (against those wicked people who wish to introduce the metric system into America) "signifying nothing" (to those who are habitually using this system in Europe). I am one of those, and the idea that the metric system could by any stretch of imagination be called a fallacy, is, as I said above, a revelation. Although I have in my own professional work now used the metric system for the last 10 years I have not yet discovered that it is a fallacy. On the contrary, I find it for practical work more convenient, and for scientific work more direct, than the English system.

The book, as the preface tells us, is the outcome of a paper read before the American Society of Mechanical Engineers in December, 1902, and the discussion therein; and this may in part account for the scrappy and somewhat disjointed character of the contents. The main reason lies, however, in the subject itself. The authors set themselves the task to prove that the metric system is a fallacy; and this cannot be done by close reasoning and marshalling of facts (indeed the facts point the other way), but must be attempted by giving opinions culled from letters, newspaper articles, evidence given before a Congressional Committee and similar sources. This stringing together of quotations must necessarily give the contents a somewhat disjointed appearance. A good half of the volume deals with textile industries and will, therefore, have little interest for the readers of this journal. The authors show that certain calculations which the weaver has to make, turn out a little more complicated if he uses the English and metric system together, than in the old way using the English system alone. This was to be expected. In the few samples, where purely metric and purely English calculations are contrasted, the balance is, on the whole, still slightly in favor of the English system, but this does not justify the authors in calling the metric system a fallacy. Whatever the methods may be by which textile manufacturers carry on their industry, the fact remains that on the Continent of Europe textiles are sold by the meter and not by the yard.

In some cases the authors are not very logical. They point to the confusion which they think exists in Germany because the foot has half a dozen values, but they fail to draw from this fact the only logical conclusion, namely, to discard the foot altogether and substitute the meter. This has, indeed, been done, although the authors maintain the contrary. They say that mechanics, carpenters and builders in Germany work to the foot and inch and that confusion becomes worse confounded, inasmuch as some use the English and some the Rhenish foot. They give even illustrations of folding rules on which inches and centimeters are marked. This statement, that the foot is still used in Germany, contains a scintilla of truth, but not in the sense the authors mean. They obviously wish to create the impression that the foot is used to the exclusion of the meter, that engineers' and architects' drawings are marked in feet and inches and that artisans prefer to work to a non-metric measure. If such were the case, it would be in direct contradiction with what the authors say on page 12. The passage is so characteristic of their view of industrial life on the European Continent, that it may be repeated here: "Nowhere has the system (they mean the metric system) made material progress in industry except when backed by the policeman's club." The idea that the police interfere in a private contract between me and my carpenter is simply preposterous! The carpenter has long ago found out for himself that it is convenient to work to the millimeter and if he submits a drawing for any work I may have ordered, that drawing will invariably be figured in millimeters, though in discussing the job he may talk about 11-in. planks or 4 x 6 joists. The carpenter, if he be an old man, still thinks in inches, but he works to the millimeter. If, on the folding rule, inches are figured it is merely as a matter of convenience in such cases, but is certainly no proof for the failure of the metric system.

On engineers' drawings got out in metric countries I have never seen dimension lines marked otherwise than in millimeters, and I doubt whether German or Swiss fitters could work to a drawing marked in feet and inches. The only parts of machinery where the English system is still used are screws, nuts, nipples, elbows and such like fittings. Of this fact the authors make the most, and on page 42 they give the German pipe and pipe thread standard of 1903, which contains both millimeters and inches. Every practical engineer understands why screw threads cannot be changed, and no advocate of the metric system is so bigoted as to refuse in special cases in English designation. Of the fact that rivets, boiler-plates, angles and all sorts of bars are invariably measured and standardized by the millimeter the authors say nothing; neither do they mention the fact that for the last five years Germany has had a millimeter standard for the screw thread of the Edison lamp. Previously to the establishment of this standard by the German Association of Electrical Engineers, the lamp sockets and holders were made to so-called English standards, with the result that lamps bought at one shop would not fit the holders bought at another. Now the despised millimeter has come to the rescue, gauges have been made to metric measure, counter gauges to rectify these are kept at the Reichanstaldt, and any one wishing to do accurate work in lamp sockets and fittings can do so. In this case the metric system has certainly not proved fallacious. Another similar case, on which the authors also observe a discreet silence, is the standardizing of flanged piping and spigot and socket piping, both for iron and earthenware. These standards have also been based on the metric system and are used throughout Germany.

The above examples will show that the authors have carefully left out of their book all facts in favor of the metric system, and have made the most of those cases where the metric system has not completely displaced the English system. To use such arguments as a proof of the fallacy of the metric system is scarcely convincing; this the authors must themselves have felt, for they try to strengthen their case by an attempt to show that the metric system has not only failed in supplanting the English, but that it has also failed in supplanting the local systems of measurement in each country.

On pages 60 to 69 is given a list of weights and measures which are supposed to be "Non-metric units used in metric countries." This list is quite misleading and the more so, as it is given on the authority of the Bureau of Foreign Commerce of the State Department, Washington. By the title of this list the reader is led to suppose that the units therein given are *now* actually and universally used in the different countries. In reality the list is a collection of units which *have been* more or less generally used in previous times, but which are gradually falling out of use. As an example we may take the "pound," for which no less than 11 different values are given for Germany alone, leaving the reader to suppose that 11 different units for the pound are actually in use in Germany. This is not so; the unit "pound" is used, and it always means the mass of 500 grams quite irrespective of the locality. In this case the introduction of the metric system has not done away with the designation "pound," but has given it a definite value. Other units like the foot, or some cubic measures are merely used colloquially as a matter of convenience, but not to denote an exact quantity. Thus, if your wine merchant offers you an "ohm" of Moselle you know that he will supply the wine in a cask containing about 220 liters; but the invoice will be made out, not in ohms and fractions of an ohm, but to the exact number of liters the cask happens to contain. The terms "ohm," "oxhoft" or "fuder" are merely convenient des-

ignations for the approximate definitions of certain quantities; they have been used for centuries and colloquially their use has not yet died out. As an exact measure for commercial purposes they have, however, given way to the metric system. It is, therefore, quite misleading to represent as the authors do, these non-metric units as if they were still in commercial use to the exclusion of the metric units.

On one point the book under review is absolutely silent, namely, the value of the metric system to the scientific engineer. Anyone who has designed machinery, first by using English units and then by using metric units, will appreciate the great saving in time and mental effort in the latter case. Electrical engineers especially have found out the great advantages of using a system which is so closely connected with the c.g.s. system, and I know several English engineers who, although they figure their drawings in the English system, use the metric system in getting out the designs. To talk of the metric system as being a fallacy is, in the light of the experience of engineers on the Continent of Europe, simply absurd.

BERLIN, GERMANY. GISBERT KAPP.

THE METRIC SYSTEM IN FRANCE.

While in Anglo-Saxon countries most men who are seriously interested in the world's progress contend for the introduction of the metric system, there remain some more timid, or attached on principle to old institutions, who are defenders of the old system and who strive to build a barricade of arguments against the march of progress. Among the arguments which are repeated by this phalanx, perhaps more clamorous than numerous, of enemies of the metric system, some are worthy of consideration, and others are to be rejected as worthless. The best reason which has been offered against the adoption of the system, which has everywhere brought progress in its train, is that any change in a system of weights and measures entails a very considerable expense, and that this expense increases in proportion as the commercial and industrial situation is developed; that, notably in the United States, the sum involved in the reform is enormous and would constitute a transient burden upon internal commerce and industries generally. No one denies the magnitude of this burden; the most enthusiastic partisans of the metric system do not disregard it. But the opponents of the system have greatly exaggerated it, and the example of the other nations which have already consented to the reform at a stage of industrial development which is comparable, if not equal, to that of the great American Republic, is there to bear witness to its advantages.

This, then, is the real argument upon which opposition rests; and the opposition would be to a certain extent legitimate if it were not fully demonstrated that the "brain-destroying system," as Lord Kelvin called it, in a vigorous arraignment of the British system, costs the Anglo-Saxon people each year sums of money and energy considerably in excess of what would have to be applied to a reform.

But, side by side with this argument, which is tenable only when one does not examine both sides of the question, there are others which are erroneous and unworthy. The more cautious defenders of the Anglo-Saxon system pass these arguments over in silence; but Mr. Halsey, who is perhaps more vigorous in his attack than fortunate in his choice of arms, adopts them all pell-mell; and, after having developed them in a number of newspaper articles, has recently compiled them in a book, doubtless to serve as a textbook for those engaged in repelling the metric system.

It is certainly true with some writers that logic is short-sighted. Issue is taken with the metric system for its decimalization, which diminishes the number of common factors; but does there exist one American who envies England her monetary system? Are there not enormous difficulties for everyone who, accustomed only to dollars and cents, finds himself suddenly in the midst of pounds, shillings and pence? Does not the American merchant rejoice in the elasticity of a system which, without any calculation, permits him to fix his discounts at 2, 2.5 or 3 per cent., while the English must cling to 2.5 per cent., because this rate alone can be used easily in passing from one denomination to another? "Sixpence to the pound." This is the almost invariable formula of the discount, because the British system of money is not decimal. These are facts which decidedly weaken the opposition to the decimal system based on the poverty of its common factors.

After a brief but vehement introduction, Mr. Halsey in two successive sections reviews the pro-metric arguments and the anti-metric. In his titles, at least, he shows a most praiseworthy impartiality; but this impartiality goes no further. Mr. Halsey knows well the authors who have advocated the metric system; he even quotes from their writings; but, to weaken the effect of their arguments, he repeats only their conclusions, as for example that of Mr. Stratton: "The experience of other countries has shown that the inconvenience and expense have been greatly overestimated," or that of Prof. Newcomb: "My conclusion is that the system can be introduced with great advantage to all coucerned * * * "; and finally, that of Lord Kelvin: "I believe that in a fortnight people would be so accustomed to the perfect simplicity and easy working of the metrical system * * * ."

It would be indeed interesting to know upon what considerations these eminent partisans of the metric system base their conclusions. Mr. Halsey seems to attach little importance to this, and assuming that these phrases have always appeared isolated from a context, he concludes from them that: "The pro-metric argument is, substantially, an *à priori* argument. The metric advocates adopt the method of the old philosophers who laboriously sought to prove what ought to be." Voltaire once said: "Show me three lines of a man's handwriting and I will hang him." Mr. Halsey is happily unable to tighten the noose about the neck of the writers whom he quotes; but he tries to make their opinion ridiculous by neglect of the facts upon which their opinion is based. In the judgment of every impartial critic, this method of discussion can injure only the man who employs it.

Mr. Halsey is more systematic in his dealing with anti-metric arguments. He develops them along seven lines:

1. The changing of a people's system of weights and measures is a task of enormous difficulty.
2. The adoption of the metric system involves the destruction of all mechanical standards.
3. The prosperity of foreign trade requires in no wise the adoption of the system as a basis of manufacture.
4. The bill now before Congress is a compulsory measure.
5. The metric system has for industrial purposes no such superiority as is claimed.
6. The confusion which is said to prevail in our weights and measures is a friction.
7. That, measured by the number of units in common use, and by their uniform value in all sections and all industries, we have the simplest and most uniform system of weights and measures of any country in the world.

These are the propositions which Mr. Halsey proposes to develop and demonstrate in his book. We shall see how he achieves this. But let us, in passing, salute the last, with a smile! Moreover, certain assertions of Mr. Halsey do not seem even to him very well founded, and he but further weakens them when he adds, in connection with the third: "This is not to be understood as referring to its use in commercial literature and correspondence. It is the commonest of common sense to say that commercial information for metric countries should be given in metric units." This is, in effect a condition *sine quâ non* of regular commerce with "metric countries"; that is to say—and Mr. Halsey himself has said it well—with the entire civilized world, with the temporary exception of Russia, Denmark and the Anglo-Saxon countries. Let us note in passing this dualism, which peculiarly weakens the idea of simplicity and uniformity to which Mr. Halsey attributes so much virtue in the system now employed in the United States. All merchants having relations with foreigners are exposed to the inconvenience of using the two systems side by side in their commercial transactions, and consequently of establishing at each step, computations of equivalent values. Moreover, one cannot deny that commerce and manufacture can rarely remain independent of one another; a manufactured article whose value is indicated in inches by a simple number has of necessity a lengthy millimetric equivalent (Mr. Halsey insists upon this on page 92) and the diagram of the dimensions of the parts of a machine quickly becomes overladen with figures which must be regarded as useless by the customer. The same problem will be found in dealing with parcels, which would be accepted with difficulty in multiples of 453.56 grams. But it is especially in dealing with valuations that Mr. Halsey is most positive in his reasoning, which he endeavors to base on statistics. He does not deny, it is true, that the Anglo-Saxon system comprises in theory 64 units; but he reduces the number, in practice, to 19, contending that a

great number of the first total exists only in school books, for instance the league, the furlong, the barleycorn, the rood, chaldron, quarter, sack and dry gallon (p. 16). If this is really so my readers know better than I; but the difference between 19 and 64 is great.

In comparison with this number, 19, Mr. Halsey estimates at 30 the number of units in current use in metric countries. Can this be taken seriously? Before answering, it will be necessary to know upon what Mr. Halsey bases his statistics. It is true that units differ in name according to the measure of size: the microscopist uses the micron, the constructor uses the millimeter and the surveyor the meter and dekameter; artillerymen employ the hectometer and cyclists the kilometer. But these are by no means different units; the meter, its multiples and sub-multiples, are but variations of one and the same unit. Similarly, the milligram, gram, kilogram and metric ton constitute but a single unit, of which each can be written in terms of all the others by displacing the decimal point. And just in this is shown one of the dominating qualities of the metric system—to be able to adapt itself marvelously to the expression of magnitude of all orders and, therefore, for all objects of the same nature, in terms of a single unit, by simply moving the point to right or to left, at will, and making it possible to find instantly the especial unit which applies to the object to be measured. English-speaking peoples have grasped the practical sense of this so well that in the special instances of the most usual subdivision they apply the decimal system and express minute measures in tenths, hundredths, thousandths and ten-thousandths of an inch, in direct contradiction with the spirit of their system and in absolute accordance with the principles of the metric system.

Could Mr. Halsey reduce to 30 the number of units in the interminable table, filling nearly ten pages (pp. 60 to 69) of fine print of all non-metric units used in metric countries? This table would be a strong argument against the system if it were not, for the greater part, pure imagination. Is it possible to accept this argument seriously when one sees cited units used in Persia and in China? Or does Mr. Halsey not know that these two countries have not yet legally adopted metric measures? Is he ignorant of the fact that Copenhagen is the capital of Denmark and that Malta is an English possession? Can it be imputed as a crime to merchants of Constantinople and Alexandria that they use units foreign to the metric system, since Turkey and Egypt have as yet adopted this system only as an approved standard?

But Mr. Halsey goes even further; he reproaches metric countries for using metric units!

Here is a short table, selected from those he gives. We add to Mr. Halsey's table the metric equivalents:

Country.	Name of Unit.	Value in American Units.	Value in Metric Units.
Holland	Ell	1.094 yards	1.000 metres
Holland	Kan	0.2642 gallons	1.000 litres
Greece	Litra	0.2642 gallons.	1.000 litres
Greece	Mina	2.2046 pounds	1.000 kg.
Germany	Tonne	2204.6212 pounds	1000.000 kg.

This is but one instance; it would be easy to carry it much further, but the instance here cited shows the ease with which he affirms what he believes will serve his argument.

Shall I go further? Shall I advise Mr. Halsey to investigate whether the *ruthe*, an old German measure, is still used in Geneva, a city where French is spoken, and whether a measure of *length* is expressed in *bushels?* Can we accept the translation of the *pfundschwer*, an old German unit, in terms of the *yard?* But it will be said these are simply oversights, and there remain enough units in the table to verify Mr. Halsey's argument. He notes, for example, the instance of sixteen separate pounds used in different Swiss and German towns; but outside three of these (a misprint being corrected), which are equivalent each to exactly 500 grams, and form the transient unit employed almost everywhere at the outset of the metric system to help in its acclimatization, I can affirm, without fear of contradiction, that no one in the countries or cities he mentions knows at the present time the units which he quotes.

It must be borne in mind that a casual observer is easily deceived by popular expressions. In Paris, for example, the vendors of watercress call out their wares "at six liards a bunch"; but this cry, which has continued unchanged since the eighteenth century, carries absolutely no meaning connected with a liard to the mind of either those who offer their wares or to the housewives who buy—the liard being a coin of which no one to-day knows the value, save archæologists and numismatists. Had I not known that "six lairds a bunch" means "two bunches for fifteen centimes," could I not easily have supposed that the people of Paris counted in liards? Such an instance as this would doubtless have rejoiced the heart of Mr. Halsey, and would have received the cordial hospitality of his table—if this had extended to currency.

It is important when one is endeavoring to obtain an exact idea of the extent to which the metric system is used, to keep quite apart popular expressions and commercial realities. One may order a *pièce* of wine, a half-*pièce, a feuillette* or a *muid;* but no one is deceived, and the bill reads: "One *pièce* of wine of 225 liters, at X fr. per hectoliter." *Pièce* here has absolutely no meaning other than that of a cask of approximately usual capacity; and, although it might well seem desirable that these casks had each an approximate capacity of 100, 200, 500 or 1,000 liters, it would perhaps be a little hard on both merchant and customer not to allow them to deal with as many liters as seemed convenient to both. Mr. Halsey does not rely on his table; he comments upon it while asserting it; but it will be noticed that the greater part of his assertions have to deal with South American republics—in some of which it is certain that civilization does not advance with rapid strides. When treating of Europe, Mr. Halsey is less felicitous. Most of his statements could easily be refuted by the impartial observer of facts and by well-established statistics. His most lengthy comment is devoted to Switzerland, to which he imputes (insisting upon it in a footnote) a system of a foot of ten inches, equivalent to three decimeters, and of a pound of ½ kilogram, divided in sixteen ounces, without mentioning other units. Mr. Halsey is behind the times; the system he refers to was once legal in Switzerland, as a transitory system; but was abolished in 1877, and, if, in the vernacular, the term feet is still used by some, I do not believe it would now be possible to make a purchase in that measure in any Swiss shop.

It concerns us little that Mr. Halsey should criticise certain parts of the North Sea coast for using in their active commerce with England the units of that country. While waiting for Great Britain to definitely adopt the metric system, it would be necessary to put a stop to all commercial relations with her if these ports refused absolutely to understand her units and to accept bills of lading and shipments based on her system. This will all be changed doubtless when the United Kingdom shall have entered into the great world movement of weights and measures. But Mr. Halsey is mistaken when he seems to think that measures of sea voyages are often given in English miles. It is convenient in navigation to identify angular measures of great circles of the earth with the measures of the distance traversed on the ocean. Now the usual angular unit in navigation is the sexagesimal minute; a certain number of minutes of arc are traversed, which can be measured directly. Now, to identify this measurement of angle with a measure of length is only natural; hence, the mile of 1,852 meters, used to some extent by all sailors. It will not be possible to get rid of the nautical mile except by the introduction of the decimal division of angles into marine service. Experiments made in the French Navy with this end in view have been absolutely conclusive, and the reports of the commanders of five vessels of the French Navy on which these experiments were carried out over a period of about a year, have unanimously recommended its adoption. Financial questions alone have until now prevented the accomplishment of this reform. But one should note in passing the superiority of the metric over the English system in all that concerns the nautical mile. Here no confusion is possible between the mile and the kilometer; in England the coexistence of the two miles could lead to many errors.

From this excursion into metric countries, Mr. Halsey concludes: "The whole metric case is riven into shreds by the simple fact that these old units will not die. Shall we carry our heads in the clouds of speculation or shall we consider the experience of others? Arguments based on the 'beautiful interrelation and correlation of the units' have little more application than a philosophical speculation regarding the appearance of the back side of the moon."

Such is Mr. Halsey's principal argument. While admitting that the metric system has a certain artistic beauty, he questions if it possesses sufficient practical value to warrant imposing it upon people by legal enforcement. This would be indeed a serious criticism. But we have just seen what weight can be given to the table compiled by Mr. Halsey. Leaving aside a number of references to non-metric countries and even to English colonies, and the reference to strictly metric units, even though some of these are known under local names, it contains nothing, with a few exceptions, but units that are pretty generally forgotten, and which are recalled to memory

only through the language of the masses. Only the ports of European continental countries carrying on commercial relations with the coasts of all countries accept merchandise weighed and measured in the units of the country which exports them, and invoiced in these units, because they cannot do otherwise. This twofold system is not the fault of the metric countries, which are practically powerless to impose their will, even as purchasers, on foreign importers; and it will disappear when the old system of the countries whose products we purchase, ceases to exist.

In the preceding I have, like Mr. Halsey, made statements without offering proofs. The criticism made of him might with apparent justice be made of me; for I offer no figures, and his book abounds in them. But, as opposed to the consular reports, which he has consulted and which apparently were compiled for the purpose of forming as complete a collection as possible of units one might possibly hear named, while talking to very old people who live in the remote corners of the earth, or to collectors and archæologists, I can fortunately refer to a document equally official and of equal importance, the result of an impartial investigation made by properly accredited diplomatic agents in all countries by the government of Her late Majesty, the Queen of England, and the present King. This document has been placed on sale in London under the title: "Report of Her (His) Majesty's Representatives on the Metric System." The entire reproduction of this would annihilate the greater part of Mr. Halsey's statements. But it is voluminous and I must limit myself to a reference to it.

Mr. Halsey pretends (Argument 5) that the adoption of the metric system would not prove an industrial advantage. He does not deny, however, that everyone is not of his opinion; he even quotes Dr. Wiley: "How, when you see the beautiful relations which exist between the units of length, weight and capacity * * * ," or Dr. Gedding: "It is simple, elastic, scientific, and on the whole a beautiful structure, and the interrelation, I think, only requires a very limited consideration to appeal to anyone who is desirous of getting into the ranks of the progress of the age."

These advantages quite fail to arouse Mr. Halsey's enthusiasm, and he condemns them in these words: "Was there ever such a case of rainbow chasing? Are we a nation of dreaming idealists and transcendentalists that we should be swayed by such considerations?"

Evidently, in Mr. Halsey's judgement, simplicity and correlation are purely æsthetic qualities, having nothing to do with practicality —at least, not in measures. In currency, however, he appreciates these advantages, since he states (page 116) that "The superiority of the decimal system as applied to currency is largely due to the great amount of adding to be done." Does Mr. Halsey then consider that measures are not also to be added up?

Further still, measures are being constantly multiplied among themselves or by some sum of money, and multiplication, even more than addition, demands a simple system by which one can pass from one unit to another by the displacement of a decimal point.

Does Mr. Halsey really think that it is "rainbow chasing" to find immediately and without pencil and paper, the price of an article in cents per centimeter, when the value in dollars per meter is known? Or the price in cents per liter, when the price in dollars per hectoliter is given? He seems to think that in daily problems it is a matter of indifference that the cubic decimeter and the liter are interchangeable, and that a liter of water weighs a kilogram.

Let us consider for a moment a simple problem, and one not created for special pleading:

A reservoir 3.50 meters long and 1.60 meters wide is filled to a depth of 1.20 meters with petroleum of 0.85 density. How many liters (or hectoliters or cubic meters) of petroleum does it contain, how many kilograms (or metric tons) are contained, and what is the value at 22 francs a hectoliter?

These various questions require the following simple calculations only:

$$3.5 \times 1.6 = 5.6$$
$$5.6 \times 1.2 = 6.72$$

Volume = 6.72 cu. meters
67.2 hectoliters
6720. liters

$$0.85 \times 6.72 = 5.712$$

Weight = 5.712 metric tons
5712. kilograms

$$22 \times 67.2 = 1478.4$$

Price = 1478.40 francs.

And the price at 22 centimes a liter could have been estimated without changing the problem one iota. And now if one will try to work out a similar problem in British units, he will soon be convinced that the act of putting the problem in the simple form, as above, is not that of a "dreaming idealist."

I am aware that Mr. Halsey recognizes that the metric system has advantages in the calculation of volumes; but he questions whether this be a frequent calculation. Has he, then, never had occasion to deal with such calculations as the weight of rail per running yard, knowing its section in square inches?

Mr. Halsey finds still other arguments not only to combat the organization of the metric system, but to challenge its superiority over the British system. These latter reasons are specious, but as they might put one on the wrong scent who did not examine them closely, we shall discuss them in detail.

On the subject of the relation between the meter and the earth's meridian, two opinions have successively held sway; the first, universally accepted at the period of the elaboration of the metric system, was the importance of establishing as complete an identity as possible between the material meter and its geodetic definition; the second, which is accepted to-day, is that the very slight error made in the construction of the meter is of no importance. Mr. Halsey contests these two opinions, and, after having quoted the statements of Captain Mahan, Prof. Stratton and Dr. Barnard, exclaims: "Save us from our friends."

No, there is no need of protecting the metric system from its friends, for the two opinions which have just been reviewed are absolutely compatible; the only reason for their apparent divergence being that they occupy two different domains: history and actuality, daily requirements and metrology.

If you will turn back to the period when the system was created and read the broad and beautiful statements of the great scientists who conceived its principles and construction, you will see that, above the desire for a perfect organization was recognized as fundamental the condition of the extension of a system throughout the civilized world; a system which should be completely separate from the old measures, and which, from its very start would adopt no existing national unit, thereby avoiding international jealousy. France sacrificed the foot, the toise and the pound—it seemed but natural that the yard should go in its turn. This idea once accepted, two ways opened before the commission—to mark off on a bar of metal a certain random length, to be accepted as a fundamental unit, or to identify the basic unit with some important natural constant measure, which was also relatively easy to reproduce. Between these decisions the commission could not hesitate; a new unit, entirely arbitrary, would consummate the sacrifice which France made of her old measures, but would not offer any particular advantage, nor any invocation of natural law that might facilitate its adoption. The idea of selecting a unit from the earth's dimensions ought to prove attractive by its very simplicity and its universal character; from the moment when the old measures were abandoned, no basis could seem more desirable, none more acceptable to all nations. To this natural sentiment was added another consideration that ought to weigh heavily in the balance of decision: The dimensions of the earth were then considered practically unalterable; it would, therefore, be an easy matter, if the standards of the metric system were lost, to reconstruct all the units from measurements at the disposition of all periods and all nations.

To fully comprehend the value which attached at that time to this condition, one would have to study the important historical researches on the measures of ancient peoples, which, like many interesting preoccupations, marked the close of the eighteenth century. It was then deplored that the Egyptians and Greeks had not better defined their units in terms of certain natural constants, which would have allowed their reconstruction with the same exactness which characterized the metrological operations of those nations.

This feeling being recognized as existing, the great pains which Delambres and Méchain, with the other members of the commission, devoted to the determination of an arc of a meridian, are easily understood, and historical opinion is also explained.

In order to understand it yet more fully, it must not be forgotten that, under the reform, the measures of a distance at sea ought to correspond with those of the angles, of which I have spoken above; the fourth of a meridian circle being divided into 100 grades, subdivided into decimal fractions, the minute, as hundredth of a grade, ought to be practically equal to a kilometer of the earth's surface; the second, as hundredth of a decimeter, would become the dekameter. This part of the reform was not effected at the same time as that of weights and measures, but it has since been considered in different countries, and has now every chance of final realization.

Perhaps Mr. Halsey will ask: "But how will you reconcile the

discord between the real meter and its definition?" The answer is easy. The agreement anticipated by the commission on the meter is important only in that the centesimal minute of one hundred seconds shall be *practically* equivalent to a kilometer; but since after a voyage such as that from Havre to New York, the discrepancy amounts to only a fraction of a kilometer, there is no navigator who could perceive it. And, moreover, uncertainties of even a higher order are inherent in the problem, and have to do with the very form of our earth. The meter is taken from the meridian; the equatorial circle differs from this, and the ratio between the lengths of two arcs of the same angular value is much farther removed from unity than the real meter is from its definition. Now the best proof that an approximate agreement only is necessary, is that navigators have created the nautical mile, of which I have spoken above, to correspond with the minute of one particular meridian, and which is not exactly identical with any other, owing to irregularity of the earth's dimensions.

The modern opinion is equally well sustained. Questions of national pride being sufficiently eliminated at the outset, from the discussion, the first conception of the meter commission, so important at the beginning of its work, has become much less important. The progress of metrology has taught us that the meter is better defined by the distance between marks on a bar of platinum-iridium than by the terrestrial meridian; and that the reproduction of copies is infinitely easier. The great work of the second commission on the meter, of which the International Bureau of Weights and Measures is the executive, has distributed throughout the world copies of the meter to such an extent, and subject to such precise investigation, that the value of the fundamental unit is much more solidly guaranteed than by length of angle measured on the globe. It is on account of these reasons collectively that the relation with the meridian, important in the propagation of the system and for the guarantee which it offered at the time of its creation—important to-day as closely related with the future of nautical calculation—has ceased to have interest as a rigorous relation in the limits of precision of the best actual measures.

It is the same when one considers the relation between the kilogram and the cubic decimeter of water; here the connection is so close that, in any calculation carried out to four decimal places, it can be considered exact. Not until the fifth digit is reached is any difference apparent; and it will be admitted that in the immense majority of cases those who use the system will never have to take this into account.

If, in the problem solved above, instead of giving the density of the petroleum at 0.85, we had stated it as 0.8523, the result obtained would not have been subject to alteration within the limits of practical application after the last multiplication was finished; it would have been the same if the dimensions of the petroleum reservoir had been represented by such figures as 3.5027 meters; but when commerce shall demand that reservoirs be measured to within several hundredths of a millimeter, then the result will have to be submitted to its very slight correction, resulting from the disagreement between the liter, the volume of the kilogram, and the theoretic cubic diameter. It is not probable that anyone now living will ever see the time when it will be considered necessary to devote days of labor or require instruments of great precision for the measurement of a reservoir or the gauging of a cask. And, until then, no one will have to take into account the metrologic imperfections of the system, which Messrs. Mahan, Stratton and Barnard consider insignificant, and which prove such a source of torment to Mr. Halsey.

These, then, are the most virulent of the attacks which Mr. Halsey directs against the metric system in so far as the system deals with weights and measures, or against the advantages of its introduction into the United States. The others are of less importance, and it has seemed to me useless to indefinitely prolong this review. I should, however, like to say to Mr. Halsey, before leaving his book, that, if the fact of passing over in silence some of his arguments could be taken as an indication of inability to refute them, I should not have hesitated to discuss each in turn.

Let us continue, therefore, the preceding discussion. The theoretical consideration of the advantages of the metric system, so interesting in itself, so desirable if they can aid the adoption of the system by so great a nation as the American Republic, would carry little weight if history taught us that this great improvement introduced into measures by men of the Revolution, amounted to only certain fruitless, abortive efforts, without practical application after a century.

But when one studies the glorious development of the system and follows its evolution and progressive assimilation by civilized nations, then it will be understood that its forward march is irresistible, and that in time it will be the universal system.

It would be puerile to deny that in France, the cradle of the new system, its adoption has been slow; but when one takes into consideration the political commotions that followed its first introduction; when one recalls the political reaction which sought to wipe out all trace of the great progress which it had made; above all, when one considers the immense effort that was necessary to establish and organize it in all its details, and that faith in the possibility of its final accomplishment was lacking—then it can be understood why the first steps were slow and painful. During the first thirty years of the nineteenth century, France was almost entirely surrounded by countries which gave no recognition to the metric system; alone, she had to make a breach in ranks hostile or indifferent. This prodigious undertaking she has been able to carry to fulfilment, because it was done in the path of progress. It would have been impossible, under these conditions, to impose the use of a new system which was a badly designed or a complicated one. But the fine construction of the metric system, the ease with which it may be acquired, its eminently practical qualities, have powerfully aided its adoption and have finally brought it into world-wide application.

And, nevertheless, by what misgivings was not the beginning surrounded, even among those who understood the advantages of a simple system. In the introduction to his great work on the Russian measures, Kupffer wrote, in 1841, that "Uniformity of weights and measures in all Europe is a chimera experience has but too closely demonstrated; but it is always a good idea, and the loss so deeply regretted by science of the ancient units of weights and measures of Rome, Greece and Egypt furnish a plausible reason for demanding that new units should always be easily reproducible if lost." And elsewhere, "The introduction of a universal metric unit, like the meter of the French commission, whose purely geometric nature should place it entirely beyond national dispute, seems to me one of those Utopias to which the soul of man loves to soar, but which offers unsurmountable difficulties in the accomplishment."

Kupffer also stated, "The linear measure in Russia is the same as in England; the only difference is in the divisions; the two empires whose power and commercial relations are the most widely extended over the globe have then the same linear measure."

Now that we are supported by grateful appreciation of the system in itself, who could make Kupffer now say that its adoption is Utopian? When he wrote what is just quoted, the system had only just emerged, in France, from the retirement into which it had been forced by the decree of 1812. The states which formerly constituted the Low Countries had preserved it, under local names, some of which have still survived; the Lombardo-Venetian Kingdom and that of the two Sicilies also possessed it; in these countries only did it live. Its existence was a precarious one, and one might reasonably suppose that the immense coalition which gave to Russia the same unit as that of England would soon reduce it to a mere memory.

But events soon proved Kupffer's pessimistic prophecies to be false. In 1849 Spain adopted the metric system; the different Italian states, Piedmont, the Grand Duchy of Modena, declared it obligatory in 1845 and 1849; Portugal in 1852; Switzerland adopted, in 1851, a transient system of a metric foot and pound, but passed in 1877 to an obligatory metric system; then followed the South American States; while in 1866, almost simultaneously, the United Kingdom of Great Britain and Ireland and the United States declared it legal. In 1871 Germany and Austria-Hungary joined its ranks, while the Scandinavian States, with the exception of Denmark, adopted it in 1882 and 1889. Mexico had already accepted it in 1857, and a decree of 1861 fixed its use in that country. At last, as if to give the last blow to Kupffer's argument, the *sagene* of seven English feet was replaced by the *archinne*, and the metric system was authorized in Russia by a law which went into effect January 1, 1900.

I have not mentioned all the continental European countries; one only among those that follow in the march of civilization, has remained legally a stranger to the system; and that is Denmark, one of whose chambers remains refractory. But there also the system has made its way; for, against the law, it is in general use in science and in engineering.

As opposed to this rapid march of the metric system, what picture does the British system present to us? The immense power of expansion of the Anglo-Saxon races has carried it to every place

where a British subject or an American citizen has transplanted the industries and commerce of these two great nations; but it has made its entrance into no other places and, outside the strictly Anglo-Saxon establishments, its zone of influence is absolutely void.

From this point of view Japan, which, by reason of her culture and her commerce, is incontestably under the influence of the English-speaking races, presents a very symptomatic phenomenon. A law which went into effect January 1, 1898, established there the rules of a new system of weights and measures. It is composed of two distinct clauses, namely: First, a system attached to old customs, but in decimal divisions, of which the fundamental units, and in consequence all their subdivisions, are in a numerically simple relation with those of the metric system; secondly, the optional use of the metric system.

Not the smallest place is offered in the new Japanese legislation for the British system. And to him who knows the care with which every important action is studied in Japan, and who knows at the same time the interest which Japan would feel in reconciling her system to English and American measures, the decision made leaves no doubt as to the strict limitation in the future, as in the past, of English measures to countries which now possess them.

Statistics ought also to be examined with care. In the count made of the inhabitants of our planet who use the metric system, and of those who are still subject to English weights and measures, the partisan of this latter system is proud and happy to be able to show a larger figure in opposition to ours. But, on closer examination, it will be found that the great contingent of followers of English measures is furnished by the 300,000,000 inhabitants of the great Hindoo delta, of whom many are without doubt as ignorant of English measures as of metric, and for whom, in addition, the Indian Government has several times besought insistently the adoption of the metric system. The adoption was recommended by the premiers of the British colonies assembled in London three years ago; and if, in place of actual and transient facts, we place the desires of the people, the statistics which oppose us will be found to be singularly altered.

In this state of affairs what is the actual situation in the United States? There is absolutely no hope that their system of weights and measures will ever be adopted by any peoples who do not already use them. History tells us this of the past, and guarantees the future. In their foreign commerce they are constantly struggling with the metric system. In all scientific operations Americans, like the rest of the world, recognize only the metric system; and if we pass from science to its applications we find the electrical industry absolutely penetrated by the c.g.s. system, which is but an elaboration, for an especial order of measures, of metric units. The product of the ampere and of the volt furnishes the watt, which is derived from the centimeter, the gram and the second. Hence, the universal unit of mechanical power is the metric unit, which is found with its congeners wherever the metric system exists, but is isolated in the midst of other units where it is not applied.

The truth is that in the United States every man whose daily occupation does not limit him to buying and selling current commodities at retail, uses side by side two systems of measures, of which one is destined to expel the other. As to the issue of the conflict, there can be no doubt.

Objection is made to the expense that would be incurred in the transformation of industrial plants and tools. And that, as I have said before, is the only reasonable objection that can be presented. It is also said that the condition of French industries at the time of the creation of the system cannot be compared with the difficulties to be met by the proposed change at this date. I grant this, but the instance is badly chosen. One single country, with very important and advanced industries, has followed in the path of the reform, namely, Germany. She has accomplished it without difficulty, very methodically and completely; and no one can say to-day that she regrets it.

France herself has recently brought about an important reform, and one which is comparable with what the United States would have to encounter if it should adopt the metric system. As decided at an international convention, the adoption of systematic metric screw-threads has become a practical realization, and no large railroad company, no large construction firm, has hesitated to incur the extra expense, knowing that they will be amply repaid in the future.

In the application of new measures to industrial constructions, there is one arrangement by which the expenses and the confusion of the period of transition can be decidedly diminished; and that is to apply new units to a new project, while preserving the old standards for all machines constructed at the time of the reform. In our age, when industry progresses with enormous rapidity, it is exceptional that a machine of a given model should continue to be constructed, without important changes, for more than a few years. Afterward, and during the several years for which the old models hold, manufacturers have to keep some duplicate parts to satisfy customers; but whether, in the interval, measures shall have changed or not, that will have no influence on the obligation of supplying these additional parts.

Such an arrangement, made by law, would bring about the transition of the industry of the United States gradually and without important expense, from the British system to the metric in less than ten years. But to accomplish this it is necessary that it be effected by legal authority and enforcement. However well persuaded one may be of the excellence of such a change, it will be adopted with great hesitation, unless enforced, a slight continuous inconvenience being preferred to an effort which is intense but of short duration.

The final word of the problem is then this: Since some day the reform will become necessary, in order to avoid the confusion which results from the coexistence of the two systems in the United States, and to relieve merchants having foreign trade now required to be familiar with them both; since, on the other side, this reform, once accomplished, will constitute an unquestioned and immense benefit; since, finally, the difficulties and the expense resulting will increase in proportion as the change is postponed—it is clearly to the powerful interest of the great American Republic to enter without delay into the ranks of a reform which has everywhere carried only benefit with it.

PARIS, FRANCE. CH.-ED. GUILLAUME.

THE METRIC SYSTEM FROM THE MACHINE CONSTRUCTORS' STANDPOINT.

It would naturally be expected that some at least among those who advocate the metric system would exaggerate the benefits to be derived from it and that others would fail to understand or even to perceive the existence of some of the difficulties to be overcome before, if ever, it can be finally and completely adopted and used to the extire exclusion of every other system. But however this may be it is certain that no friend of the metric system, here or abroad, has ever exaggerated its advantages or underestimated [illegible] ficulties in the way of its adoption in anything like the degree to which these things are done, per contra, in the book under consideration. It is of the very essence of the blindest partisanship. In that which is opposes it recognizes no redeeming qualities, even the smallest; while for the opinions and the actual experience of those who advocate the use or adoption of the metric system, even in the most tentative way, it shows nothing but scorn and contempt. The author simply cannot conceive that those who differ from him on this question—even those who disavow belief in measures of compulsion—can possibly be frank and at the same time intelligent. His reference to "the pillory" and "the scorn of men" breathes of the spirit that in former times sought to correct error by the rack and the thumbscrew and that condemned dissenters to be boiled in oil —never, mark you, to gratify the evil passions of the boilers, but for the good of the state and the welfare, here and hereafter, of the rest of humanity, inerrant.

In reviewing this book the temptation is strong to attack nearly every position taken by the author. He is so cocksure of everything from the condition of European machine shops to the proper legal interpretation of the metric bill before Congress, and in his cocksureness exhibits so little toleration for those who happen to differ from him in opinion, that the reader feels that this is a book any part of which he is at liberty to criticise without mincing words. I, however, confine myself to those things which have to do with such work as is done in machine shops, a field in which the author evidently considers himself especially invincible. In his introduction, referring to the English-speaking nations, he says: "They are asked to enter the slough of despond in which metric Europe wallows in order to help metric Europe out." Though practically every other human being should see the absurdity of that language, the author will never perceive it. He seems to actually believe that Europe is "wallowing" in something or other and that the chief reason she is "wallowing" is that she has not our beautiful system of weights and measures and has to

get along with the metric system. It is as absurd as though an ignorant and conceited Englishman should assert that we are "wallowing" because we do not count our money by pounds, shillings and pence. The author of this precious volume seems actually to believe, and in effect says, that the inch is at the foundation of our national industries and cannot be abrogated or its use discontinued in any degree without to a corresponding degree crippling our manufactures and placing us upon as low, if not a lower level, than that occupied by the European countries which now use the accursed meter. He discusses interchangeable systems of manufacture and the alleged necessity for adhering to the inch as though the two were the same thing. In the threatened destruction of the inch his disordered imagination sees the destruction of all our manufacturing interests, and one who knew no better might conclude from a perusal of the book that, supposing the inch to be done away with and the millimeter substituted for it, we should have to begin at the beginning, wear the skins of beasts, live in caves and, with such rude implements as the blacksmiths might make for us, build up all our tools and implements and devise all our standards of every kind as though nothing of the sort had ever existed. This utterly ludicrous notion seems to be derived from the alleged fact that exact equivalents in metric measurements cannot be found for measurements in English and from the further alleged fact that to adopt the metric system means that everything we use must measure to some integral number of millimeters. Both these assumptions are, of course, utterly wrong, and, therefore, all the yards (or meters) of argument which Mr. Halsey bases upon them falls to the ground.

It is a fact that our present standard inch is ultimately referred to and is based upon a standard meter bar which is the best standard in the possession of the Government and is, therefore, used as the ultimate reference standard of length for all dimensions, whether expressed in inches or millimeters. In other words, our standard, legal inch as used to-day in America is based upon a metric bar. Of course, this is done simply by knowing the ratio of length between the meter and the yard and by the possession of means of measurement sufficiently refined for the purpose. It is the same with all measurements made in one system to be equivalent to given dimensions in the other; all that is necessary is that the means for measuring shall be sufficiently refined to bring the residual error down to a negligible quantity, this quantity varying with the nature of the work to be done. At pages 450 and 1347 of Vol. XXV, *American Machinist,* it is stated by a contributor connected with the great engine works of Willans & Robinson at Rugby, England, that they have no difficulty whatever in making parts of engines by the metric system which will interchange with parts made to the English system, and it must be remembered that Willans & Robinson know as much about accurate interchangeable manufacture as any one else in the world, bar none. I very much doubt if there is a single engine building shop in America which does as accurate work and work that is as closely kept to a standard, predetermined size. They use both systems of measurement, avow that they prefer the metric and that the men do and declare, as cited above, that work made in their shops by one system of measurement may readily be made to interchange with work made by the other system. This simple statement of fact as to what is actually done, to say nothing of much other similar evidence, completely upsets all that Mr. Halsey says on this subject and makes ridiculous all his hysterical oratory about the destruction of the inch and with it the destruction of our interchangeable system of manufacturing, and the loss of our prestige as a manufacturing nation. In fact, Mr. Briggs, in the two articles referred to, declares unequivocally that they are actually doing and find no difficulty in the doing of nearly if not quite all of the things which Mr. Halsey declares so emphatically and so positively it is not possible to do and that whoever dreams of doing them only reveals his gross ignorance of shop matters. Shall we accept the testimony of a man familiar with the methods by which these things are actually done and who tells us how they are done, or the testimony of one who, so far as known, has never had the least experience with the metric system, has never been in any metric using country and merely draws upon his imagination for material upon which to base positive not to say discourteous statements to the effect that whoever thinks they can be done and dares to say so is an enemy to his country?

As a matter of fact, in the construction of machinery surprisingly few things are made precisely to integral measurements in inches or common fractions thereof. Many parts which have such dimensions nominally do not have them actually. Take for instance a bearing and the shaft to fit it, both having a nominal diameter of one inch. If finished in the usual way the hole will be hand-reamed for the final size, and if it is a part of a machine which is manufactured on the interchangeable plan there will be a limit plug gauge for this hole. This gauge will have two sizes upon it, one of which must not go into the hole, while the other must go in. Neither of these sizes will usually be exactly one inch, but if the work is fairly close we may assume that the "go-in" end of the gauge is just one inch, while the "not-go-in" end is 1.001 in. This, as we all know, means that the holes will be somewhat more than one inch diameter and somewhat less than 1/1000 above one inch. Not one of them, except by accident, will be exactly one inch. For the shaft there will also be a limit gauge and this will allow the shaft to be anywhere between, let us say, 0.9975 in. as a minimum and 0.999 in. as a maximum, and the shaft will thus never be exactly one inch diameter. The actual sizes of these gauges will be determined by means of micrometer calipers or other measuring appliances which will infallibly be based upon decimal divisions of the inch, for the simple reason that the common fractions for which the author of this book has conceived such a sudden and violet admiration have proved entirely useless for such work. And the calipers used for this gauge work and which will determine the required size within 1-10,000 of an inch if desired will also determine a metric size within that limit of error. This is a simple matter of arithmetic and of every-day shop practice. It means simply that all these refined measurements which are necessary in the maintenance of standards for interchangeable manufacturing are of necessity now measured by some decimal system; that their actual sizes seldom agree with their nominal sizes; that the actual size of a given gauge can be expressed either in decimals of an inch or in decimals of a millimeter within the limits required by the nature of the work, whatever it may be, and that standards made by one system can be measured and reproduced by the other to any required degree of precision whenever circumstances may make it necessary or worth while to do so.

Mr. Halsey ought to be familiar with the fact that very much of the very best interchangeable work has been done with little or no reference to any standard measure of length. It is quite the custom in making sewing machines, guns, typewriters and similar work to largely disregard actual dimensions in the construction of the first or model machine and to simply make the parts to fit properly and so that the machine will do the work it is intended to do. The gauges and tools of all kinds are then made to fit the parts of this machine and to reproduce them within the required limits of accuracy. To say that the actual sizes of such a sample machine and the tools for producing it could not be accurately determined by a metric micrometer is of course absurd and the pretence that if we go in for the metric system we must perforce immediately abandon all the standards we now have and take up others having dimensions actually different only affords a brilliant example of how completely an utterly blind partisan, attempting to make out his case, can close his eyes to facts which, to those willing to see, are as plain as the noonday sun. The Morse taper shanks for drills and other tools were intended to be 5/8-in. taper to the foot. The later ones are that, but the earlier ones are not and their real taper per foot must be expressed—whenever it is of any importance to know what it is—in thousandths of an inch. Do we throw them away on that account? We do not because it is important to preserve them and by means of the refined instruments of measurement now at our command we can at any time needful determine their actual dimensions. To pretend that if we adopt the metric system we must throw them away is to talk foolishness. These taper shanks are known by numbers and they would be known by the same numbers and would have precisely the same dimensions no matter what new system of measurement we might adopt. Much the same may be said of pipe threads. Their designating sizes are only nominal and their actual sizes must be and are, in the books, given in decimals of an inch. Taking a half-inch pipe tap, for instance, not a single thing about it is half inch nor anywhere near it. As given in Kent, the actual inside diameter of such a pipe is 0.623 in., or .123 in. above its nominal size, and outside it is 0.840 in., or .340 in. above its nominal size, and yet we find the author of this book telling the world that if we adopt the metric system we must throw away our

"standard pipe fittings," and that if we do not and ever think of such a thing as applying a metric caliper to them or of expressing their sizes in .01 mm. instead of .001 in. we shall be only pretending to adopt the metric system. Could anything possibly be more absurd? It is conceivable that, by the complete displacement of gas by electricity for lighting, gas pipes may be done away with, but until that time comes, if it ever does, we shall preserve our gas-pipe thread standards regardless of the system we may use in measuring them.

As a matter of fact, actual measurement is seldom required in modern manufacturing operations which have to do with standards. The men who actually do the work of producing things made to these standards work to gauges which are supplied to them and the actual sizes of which concern them very little. Tool makers and others who may have occasion to know and to use the actual dimensions of such standards always determine them by micrometer calipers or measuring machines of one kind or another and always by decimal parts of an inch. Their actual dimensions can very seldom, indeed, be expressed exactly without the use of decimals, and to say that standards whose sizes must now be expressed in strings of decimals of an inch can no longer be used after the adoption of the metric system because then to express their exact sizes by that system would involve the use of decimals is the height of absurdity. In Mr. Hennings' discussion of this matter before the A. S. M. E. he referred mistakenly as I think) to the use of combination nipples for gas pipes to be used during the transition period. Our author, referring to this, says: "Thereby acknowledging that the change is to be made." As though Mr. Henning were charged with knowledge as to just what is to be done or that he is to be the dictator in such matters; or, as though an organized conspiracy existed among those who believe in the introduction of the metric system, and that it is part of their game to conceal the darkest parts of their plot until the innocent and trusting people have been well started on the road to industrial ruin! And Mr. Halsey, by catching at such remarks, made by a person in no way responsible except for his own opinions and for whose opinions no one else is in the least responsible, imagines he has revealed this dark plot and sees himself on a pedestal as the industrial savior of the country. The sane view of this phase of the subject was presented by Mr. Samuel Vauclain, superintendent of the Baldwin Locomotive Works, when, before the Franklin Institute, he pointed out that manufacturing operations are carried on largely by men who simply work to gauges that are supplied to them and who need to give precious little attention to the actual sizes of these gauges and in fact usually know nothing of the sizes. Only the gauge makers and the designers need to know about the actual sizes and they, with the refined means now provided for measuring, can readily determine those sizes either in the English or metric system. I do not pretend to quote his exact language, but this was the gist of it and Mr. Vauclain can hardly be sneered at as a visionary theorist or dismissed as a fool who knows nothing of practical manufacturing operations. He simply recognizes the fact, which our author seems unable to grasp, i. e., that by the metric system we can measure the things we now have with such degree of precision as may be demanded by the nature of the work to be done, and that no standard that is of any value to us need be thrown away because we adopt the metric system.

At page 42 we are favored with a German table of sizes of English pipes the nominal sizes of which are given in fractions of an inch and their actual sizes in millimeters. This is declared to have been adopted in Germany and our author calls it a "delightful hodge-podge of inches and millimeters"—"the best pipe and (pipe) thread standard which the Society of German Engineers can evolve in this year of grace 1903." Well, what of it? It simply shows that German engineers, though living in a metric country, have the good judgment to make more or less use of a standard which is of value to them or which is necessary to secure interchangeability or convenience in construction. Their table gives the actual sizes of this standard in the measurements which are in practically universal use in engineering work in Germany; so that those who may have occasion to know these actual dimensions can easily find them. No one will be able to see anything absurd in this or anything to go into hysterics about except the fanatic who, in search of small pegs to hang argument upon, insists that there is no adoption of the metric system until all things, the sizes of which have been determined by inch measurement, have been destroyed and replaced by others having dimensions expressed in integral metric measurements. In other words, if a brick becomes loosened from a wall the building must be condemned because the old bricks are made to inch measurements and metric bricks must be used to replace them.

At page 18 the mechanical engineer of the National Tube Company (Mr. Taylor) is quoted as saying that lap-welded tubing is made by that company when ordered to metric measurements to the "nearest fraction of an inch, no attempt being made to get closer than 1/16 in. of the dimension called for." "Seamless tubes are made to exact metric measurements when ordered by metric measurements." This is sufficient in the mind of the author to upset the statement made by Dr. Stratton to the effect that the company named regularly supplies goods made to the metric dimensions; and, at page 43, it is further attempted to be shown that this means that very much boiler work must be done in Europe to inch dimensions. The real meaning of it is, of course, plain enough, i. e., that lap-welded tubes are not supposed to be accurately dimensioned; they are made with only a rough approximation to the nominal size and when lap-welded tubes, made here to within a sixteenth inch of the size ordered, are found upon arrival in France or Germany to be within 1.5 mm. of the size ordered they are considered good enough —all that could be expected for that class of work and are accepted. The mechanical industries are full of such instances and no one not desperately hard driven for an argument would think of referring to this one. On the other hand, when seamless tubes are ordered to the metric dimensions they are made exact. This, of course, is because exactness is expected in the case of seamless tubing, and it is to be especially noted here that the expensive tools and appliances for making tubing apply to the seamless tubing much more than to the welded, which is comparatively rough and crude. Mr. Taylor's letter when interpreted in the light of a knowledge of mechanical matters and candidly considered sustains Dr. Stratton's statement and does not in the least show that work must be done to the inch system in Europe to suit these imported American tubes.* Mr. Halsey's statements bearing upon this phase of the question are simply figments of an overwrought imagination.

Referring to this necessity for the preservation of established standards of value, Mr. Halsey grows eloquent about our system of screw threads for bolts and dramatically asks why if an English thread can be so easily converted into a metric one the nations of metric Europe ("wallowing," etc.) do not do it instead of "making these tremendous efforts to obtain a metric standard." Well, the simple reason for that is that they have in Europe no generally recognized standard thread, but use Whitworth, Sellers and nobody knows how many others, just as we did before adopting our standard. This being the fact, they have sense enough to see the advantage of a single standard if it can be agreed upon; and, as a standard is to be recommended for general use, it is quite natural that representative bodies should be convened for the purpose of considering what is the best thread to adopt. They have done this and, after considering all the known standards, have recommended for adoption what is known as the International Screw Thread Standard, which is a close approximation to our standard, but reduced to integral metric dimensions. This would seem to be the most natural thing in the world, as would also our retention of our present standard, because it is a good one and because it would cause a great deal of confusion and loss if it were to be abandoned or if an attempt were to be made to introduce a new standard. Of course, any one who chooses to write a book and who wishes in that book simply to make out a case for his side of the argument can imagine his opponents doing any fool thing he chooses and can then easily show the absurdity of their doing it; but this is not generally considered fair discussion. The entire chapter entitled "The Value of Mechanical Standards" is manifestly based upon the perfectly wild assumption that no one who knows anything of the value of such standards would for one moment think of tolerating such a thing as the metric system. The heroics indulged in here about the "pillory" and holding the metric advocates up "to the scorn of men" are, of course, mere gibberish when we consider that they are all based upon a fundamental misconception of the whole matter. Speaking of the alleged and wholly imaginary proposal to abolish our present standards and to wear misfit collars and shoes for the sake of having them made to integral metric dimensions, he says: "It is difficult to be patient or to use temperate language regarding

* If Mr. Taylor's quoted language means, as quite possibly it does, that they make the tubes to the nearest 1/16 inch, then the maximum variation from the size ordered ise of course one-half the amount given above, or 0.75 mm.

such a proposal." It is evident that he would have expressed his thought more accurately if he had said that it was impossible instead of merely difficult, for he is not patient, nor does he use temperate language. The book all the way through reveals the man who is absolutely certain that his opinions are law and gospel and that any dissent from them, even in the smallest degree, is the result of ignorance, or pure wickedness, or a combination of the two.

The metric system being decimal throughout the author in his anxiety to show that everything connected with that system is inferior to the so-called system we now use has conceived an abnormal affection for common or vulgar fractions, with a corresponding antipathy for decimal fractions. Speaking of the latter he says that "no one can be induced to use them in construction except by the force of law." It is extremely difficult to believe that any one at all acquainted with the art of machine construction as carried on to-day could say such a thing sincerely. Has the author ever heard of vernier and micrometer calipers, all of which are graduated to read in decimals and nothing else? Does he not know that the use of decimals in machine construction has greatly increased during the past 20 years, during which time the use of such refined instruments for measuring has become common and that it is now the exception when the actual sizes of machine parts can be expressed exactly in any other way than by decimals? And has all this been the result of "force of law"? No. It has been the result of the perception that Mr. Halsey's idolized common fractions are utterly inadequate for use in making the refined measurements required by present-day machine shop practice and have had to be abandoned. No one not utterly blinded could fail to see that it would be a great improvement to make all our divisions of the inch decimal. Indeed, this has been proposed as one way out of the present awkward mixture of common and decimal fractions involving constant reduction from one to the other in the drafting room and shop, costing American machinery interests no one knows how much, and which European machine builders entirely escape because they use a system wholly and consistently decimal throughout.

The testimony of those who have been much in the shops of Europe and have there found in use no other than the metric measurements counts for nothing in the mind of this man who is determined to show that Europe is "wallowing" in a mixture of metric and innumerable other measurements. He attempts to discredit such testimony, evidently with the idea that because inches are in special cases referred to in Europe, therefore the metric system has not really been adopted there, and that they are only pretending to have adopted it. It is as though a resident of New York should tell a stranger that our use of decimal coinage is a pretence because stock brokers use eighths of a cent instead of the far more convenient mills provided for in our monetary system. Such an assertion would, of course, be merely a quibble to be laughed at, and so is Mr. Halsey's attempt to discredit the testimony of observant and trustworthy engineers who have extensively visited European machine shops and declare that they never encountered in any of them any other measurement than the metric. No doubt, if they had resolutely shut their eyes to everything else and had hunted for inches only they would have found some of them and might possibly have returned home full of the belief that the adoption of the metric system in European machine shops is all a myth and a humbug. But by doing so they would only have demonstrated their own ability to shut their eyes to the larger and more important facts, and to see only those things calculated to strengthen their own prejudices.

A chapter upon which the author evidently particularly prides himself is entitled "The Government Will Pay the Cost." In this chapter he quotes the following paragraph from that part of the report of the metric committee of the A. S. M. E. which was agreed to by all its members as follows: "Recognizing the well-settled fact that the consumer does and must pay all necessary costs of production, we believe that if the Government specifies such dimensions as will materially increase the cost of production the Government and not the bidder will have to pay such increased costs, it being self-evident that a bidder, not compelled to bid, will not bid except at a price that will afford him a profit."

Mr. Halsey states that the anti-metric half of the committee has since withdrawn its approval of this point. Perhaps this is true, but if it is then one would think that some record of the fact would be found in the published volume of *Transactions* of the A. S. M. E. I fail to find any such record; on the contrary, the entire committee is there recorded as agreeing to this. And if the anti-metric half of the committee wishes to be credited with any knowledge whatever of the most elementary principles of economics, it will be careful not to withdraw its approval of this, for it is based upon economic laws that are well established and about as universally agreed to among economists as are Newton's laws of gravitation among physicists. But of course Mr. Halsey does not hesitate to attempt to prove that this agreed-to paragraph is all wrong, and he does it in a very curious and interesting manner. He says in substance that if the proposed metric law were in force and bids were asked by a department of the Government upon a machine to be built to metric measurements, all the bidders would add to their bids the full cost of the necessary metric tools; but that only one of them would get the contract. This one would be paid for his tools. But the next time similar machines would be called for he would be the only one provided with tools at Government expense and he could, therefore, underbid the others and monopolize the business. If, however, he attempted to keep his price up, some other builder might underbid him a little and thus two builders would be paid for equipments of tools, and this is as far as it could ever go. "This," Mr. Halsey says, "is scarcely up to the American idea of even-handed justice." Now, as a matter of fact, any one at all familiar with methods of cost keeping and of estimating costs in machine shops knows that the thing never could happen in the way Mr. Halsey describes. What would happen would be something like this: Bids would be asked for and whatever of increased costs might be imposed by the terms of the bidding would, of course, be considered, but tools necessary to be purchased or made in order to fill the contract would not be charged to the cost of that single order unless they were to be used up in filling that order or unless it were certain that no other order that would call for their use would ever be received, and that the tools would be valueless upon its completion. As a matter of fact, only a certain proportion of their cost would be charged to this first job, and at its completion their inventory value would be their cost less the amount charged to the cost of the job. Any new bidder coming in on subsequent contracts would do exactly the same thing, and all of them, if they knew their business, as most machinery manufacturers do, would charge about the same proportion of the original cost of the extra tools to each machine they were used upon, and all bidders would, therefore, be on the same footing. This view of the case will, it is true, not suit Mr. Halsey so well as his own, but that is only because it is based upon what actually takes place in modern machine shops instead of upon what one imagines might take place or that perhaps would take place if machinery builders knew nothing of the science of cost keeping. If, when a machine shop proprietor bids upon a job requiring for its execution a boring mill larger than any he already possesses, he were to add to the cost of that one job the full cost of the mill then he would be acting in accordance with Mr. Halsey's argument. But no sane machine shop proprietor would think of doing such a thing. He would simply charge to that job a certain amount for the use of the mill, and his competitor, already having such a mill, would do the same thing, and they would be upon exactly the same level in that respect. Thus the moment we consider the way things are actually done in machine shops, we perceive the absurdity of the author's argument on this point.

Again, if the author had really paid attention to what the above quoted extract from the A. S. M. E. committee report really says, he might possibly have perceived that it makes no mention of the cost of metric or other tools. It is written in general terms and says merely that if the Government specifies such dimensions (any dimensions) as will cause increased costs (i. e., costs determined by modern and proper methods of cost keeping) then the Government will have to pay such increased costs. There is no getting away from that fact. It is based upon fundamental economic laws and will remain true no matter who may withdraw his approval of it or attempt to show its error.

It is, however, by no means conceded that chiefs of the Government departments will be so foolish as to specify to the utmost possible limit the precise size of every component part of a machine on which they may ask for bids. A reasonable interpretation of the contemplated law is that a machine purchased for the Government shall be capable of doing work to the metric system and that is all. There is scarcely a machine-tool builder in America who does not

regularly build machines to go abroad that fully meet this requirement. True Mr. Halsey scoffs at any such "adoption" of the metric system and intimates that to do any such thing would not be acting in "good faith," by which it is to be supposed he means that it would not be pursuing the course contemplated in his strictures, which are thereby made a sad misfit. But the advocates of the metric system will probably go on advocating its adoption their way rather than the way of the one who, above all others perhaps, most strenuously opposes its adoption at all. And those who really wish to know what constitutes a reasonable interpretation of the law will, of course, take the opinion of some one versed in the law. Such an opinion has been given at length by ex-Attorney-General Knox and is a matter of record. This being so and the further fact being recognized that there is not on record the least expression of opinion by any lawyer whomsoever, eminent or otherwise, controverting Mr. Knox's opinion, discriminating readers will scarcely give much attention to the author's interpretation of it or to his weak attempt to show that Mr. Knox's interpretation is erroneous.

Space is too valuable and life too short to permit of taking up all the fallacies of this fallacious book, but enough has been given to show how much the author is entitled to contemptuously refer as he does to the "characteristic logic" of other people. Instead of being called "The Metric Fallacy," it should be "The Halsey Hallucination."

NEW YORK. FRED J. MILLER.

New Zealand Transmission Plant.

A large hydro-electric plant is being erected by the Waipori Falls Electric Power Company, near Dunedin, New Zealand, the ultimate capacity of which will be in excess of 6,000 hp. At present two 1,000-kw engine-type alternators will be installed, of General Electric manufacture, each directly driven by Pelton water wheels, having 50 per cent. overload capacity, and operating at 429 r.p.m. under 278 pounds net pressure per square inch (equivalent to a vertical fall of 665 ft). Three-phase, 50-cycle current will be transmitted 29 miles into the sub-station at Dunedin, and from there transformed and distributed for street railway, power and lighting service.

Each main water wheel unit will consist of two wheels or runners, mounted on each end of the overhang of generator shaft, the rotor being mounted between them. The shaft will be supported by two water-jacketed, self-lubricating bearings.

The contract for the hydraulic equipment, including generator bearings, shafts and bedplates, has been awarded to the Pelton Water Wheel Company, of San Francisco and New York, who will also furnish the governors. These latter will be of the hydraulic pattern, and provided with automatic switchboard control, so that the machines may be easily synchronized by a single station attendant manipulating two push buttons on a switchboard panel.

Two exciter sets will be installed, each driven by a Pelton water motor, and a 50-hp induction motor directly connected to generator, the whole being mounted on a common baseplate.

This plant will be the most important of its character in the Colonies, and is ideally located, having its market situated only 29 miles from the generating station. It is estimated that the power loss from water in flume to point of delivery for distribution will be only 33 per cent., and the power loss from the Pelton wheels to delivery for distribution, 15.1 per cent.

Two steel pipes will convey the water from a large settling basin to the wheels. Each line will be 1,825 ft. long and 42 in. in diameter at the top, tapering in sections to 36 in. at the bottom. The steel plates used in the manufacture of the pipe vary in thickness from ⅛ in. at head of line to ½ in. in thickness at bottom. On account of the abruptness of the decline from the penstock to power house, heavy concrete saddles will be provided at frequent intervals for anchoring the pipes. The piping will be well covered to protect it from sudden changes in temperature.

It is expected that this plant will be the forerunner of many similar stations, as New Zealand is a country plentifully supplied with natural waterfalls, many of them being in close proximity to the larger towns and cities. The awarding of this contract to the two above firms is a good indication that American machinery is held in high esteem in all parts of the world, as severe competition with European concerns was experienced.

World's Fair Awards to the Westinghouse Companies.

That the monumental exhibit of the Westinghouse Companies, at St. Louis, received due recognition from the Exposition juries is attested by the bestowal of a special award and the award of no less than 12 grand prizes, 8 gold medals, 4 silver medals, and 1 bronze medal.

The special award was granted for "The best, most complete and most attractive installation" in the Department of Machinery. This testimonial is the more notable from the fact that, so far as is known at present, it is the only special award made by the Exposition. The subjects of the other awards are as follows:

GRAND PRIZES.

To the Westinghouse Electric & Manufacturing Company, for "Alternating-current generators and motors, alternating-current turbo-generator installation, static transformers and rotary converters"—Group 67.

To the Westinghouse Electric & Manufacturing Company, for "Direct-current generators and motors"—Group 67.

To the Westinghouse Electric & Manufacturing Company, for "Electric railway motors, alternating-current and direct-current, and control systems for single and multiple-unit operation and for mining and industrial locomotives"—Group 67.

To the Westinghouse Machine Company, for "Horizontal gas engines and steam turbines"—Groups 62 and 63.

To the Westinghouse Air Brake Company, for "Air brakes and friction draft gears"—Group 74.

To the Westinghouse Traction Brake Company, for "Brakes for electric cars"—Group 74.

To the American Brake Company, for "Driver brakes"—Group 74.

To the Westinghouse Automatic Air & Steam Coupler Company, for "Air and steam couplers"—Group 74.

To the Westinghouse Brake Company, Limited, London, England, for "Air brakes and accessories"—Group 74.

To the Westinghouse Company, Limited, of St. Petersburg, Russia, for "Air brakes and accessories"—Group 74.

To the Union Switch & Signal Company, for "Signal system"—Group 74.

To the Cooper Hewitt Electric Company, for "The development of the mercury vapor lamp"—Group 69.

GOLD MEDALS.

To the Westinghouse Electric & Manufacturing Company, for "Complete switchboards and controlling apparatus, and the application of electric motors for mechanical purposes"—Group 67.

To the Westinghouse Electric & Manufacturing Company, for "Alternating-current, direct-current and Bremer arc lamps and arc lighting systems"—Group 69.

To the Westinghouse Electric & Manufacturing Company, for "Electric measuring instruments"—Group 71.

To the Nernst Lamp Company, for "Nernst lamps"—Group 69.

To the Cooper Hewitt Electric Company, for "Vapor lamps for photo-engraving"—Group 15.

To the Pittsburg Meter Company, for "Water and gas meters"—Group 64.

To the Westinghouse Electric & Manufacturing Company, for "Industrial betterment work"—Group 138.

To the Westinghouse Air Brake Company, for "The housing of the working classes"—Group 136.

SILVER MEDALS.

To the Westinghouse Electric & Manufacturing Company, for "Switches, fuses and wiring appliances"—Group 69.

To the Sawyer-Man Electric Company, for "Incandescent lamps"—Group 69.

To the Bryant Electric Company, for "Electric light fittings"—Group 69.

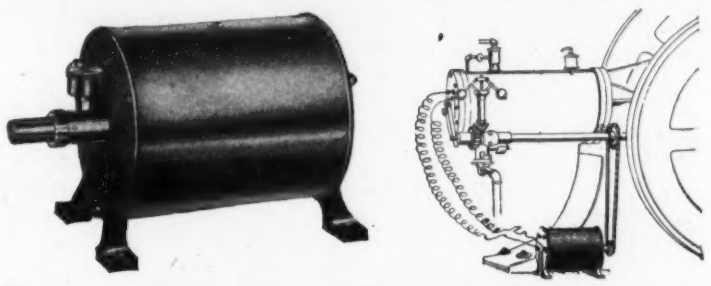
To the Société Anonyme Westinghouse, Havre, France, for "Gasoline automobiles"—Group 72.

BRONZE MEDAL.

To the Perkins Electric Switch Manufacturing Company, for "Electric switches"—Group 69.

An Induction Sparker.

A new device put on the market recently by the F. Bissell Company, of Toledo, Ohio, is the "Security" sparker for gas and gasoline engines. When used for butt sparks, as in heavy work, it is an induction dynamo furnishing an alternating current. It has no motor or brushes with their attendant troubles. The voltage is high, eight to ten on slow speed and fifteen on high speed. This is a very small variation considering the extreme fluctuations in engine speed.



FIGS. 1 AND 2.—INDUCTION SPARKER.

Fifteen volts will not burn the points. The voltage is never too high nor too low. The output is ten amperes, giving a very fat spark and making ignition sure.

The machine is rugged and compact, easily attached directly to engine, floor, wall, ceiling or elsewhere. It is thoroughly enclosed and protected from dirt, oil and dust and will stand ordinary moisture. The wiring is direct from the sparker to the engine, using no coil whatever.

Electricity in Fire Fighting.

We note the recent introduction in England of some interesting apparatus for the facilitation of the work of firemen, made by Merryweather & Sons, of London, for the Manchester fire brigade.

The novelty consists in the employment of helmets for the firemen,

FIREMEN'S TELEPHONE AND ELECTRIC LIGHT OUTFIT.

fitted with telephones and an air draft arrangement, and also in an electric lighting circuit supplying current to protected incandescent lamps which the men carry.

By the side of the steam cylinder of the steam fire engine is a single-barrel air pump, driven by a coupling and gear from the crankshaft, and also arranged so that it can be thrown out of action when desired. The air pump supplies four valves fixed on the side frame, quick hitching couplings being fitted to these valves for hose connections to the smoke helmets.

Over the fore carriage is placed a little dynamo to supply eight 32-cp incandescent lamps. This machine is driven by a belt from the fly-wheel of the engine, and is provided with a voltmeter and six reels. The latter hold 200 ft. of flexible insulated cable each, fitted to supply the lamps. A large cage is fitted in the center of the machine for carrying six 60-ft. lengths of flexible metal air hose in coils. In front, under the driver's footboard, is a box to hold batteries for the telephone service and also the smoke helmets.

Each helmet is of leather, with a mask extending over the shoulders, the front under the peak being left open. The coupling for the air hose is at the back, and the draft is distributed round the wearer's head in front, so as to keep the eyes and nose clear of smoke. Inside the mask are the telephone receiver and transmitter, wires being led through the air valves, from whence wires are carried to a switchboard, so as to enable the officer in charge to communicate with his men working in darkness or smoke at a distance.

Air Compressors for Electric Uses.

The Blaisdell Machinery Company, of Bradford, Pa., has recently designed an air compressor intended especially for cleaning dynamos, motors, light and power switchboards and telephone switchboards.

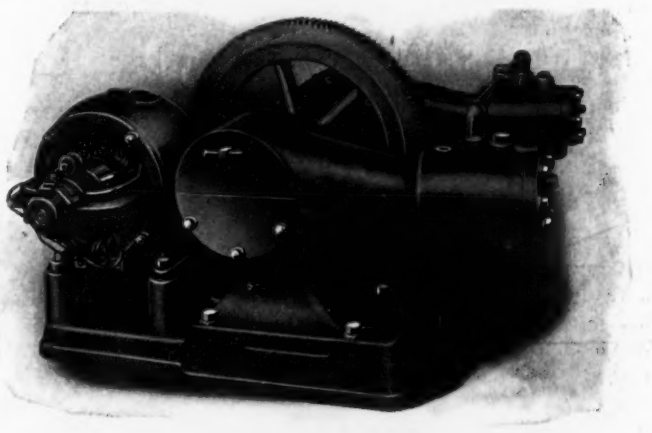


FIG. 1.—AIR COMPRESSOR.

The superiority of compressed air for this work has long been recognized, but heretofore the expense of a plant has prevented many from installing a compressor. The compressors illustrated herewith

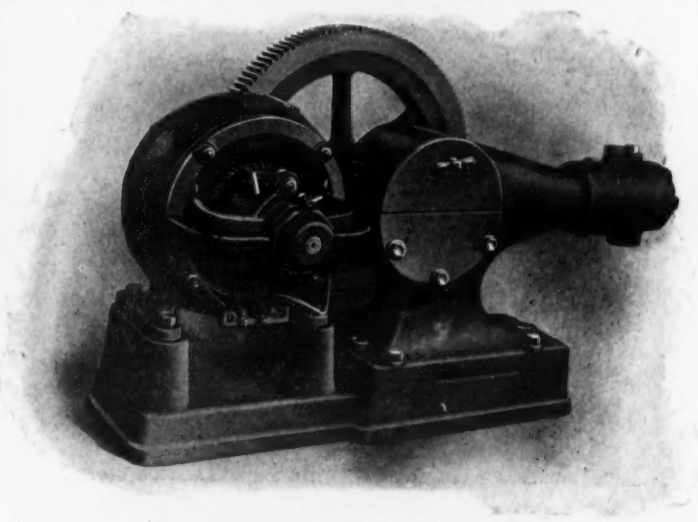


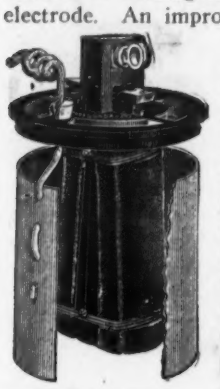
FIG. 2.—AIR COMPRESSOR.

are entirely enclosed and self-oiling and the motor is also self-oiling, requiring practically no attention. The machine can be placed in any convenient place without the necessity of an expensive foundation and can be equipped for any voltage or current.

The connecting rods and boxes are of bronze and the crankshaft and pin are of steel. The cylinders are of hard, close-grained iron. The valves cannot be drawn into the cylinder.

Improvement in Leclanché Battery.

A weak point of the gonda style of Leclanché cell has been the method of holding the gondas, or prisms, firmly against the carbon electrode. An improvement in this respect has been made by the Leclanché Battery Company, 111 East One Hundred and Thirty-first Street, New York. The carbon is made wedge-shaped, with the thick end down, and the gondas are bound tightly thereon by means of linen cord. This form, it is stated, gives a very firm and permanently secure electrode, which is free from the danger of prisms becoming detached from the carbon and thus short-circuiting the cell. The rubber holding bands in the old style of cell were liable at any time to give way, but it is claimed that the linen cord fastening in the improved cell is reliable and secure, and insures a firm and permanent contact between carbon and prism.



WEDGE ELECTRODE.

By the use of a cylindrical sheet zinc electrode the interval resistance of the wedge cell is reduced and the amperage correspondingly increased, 7 amp. on short-circuit being available. The ordinary zinc rod electrode, however, is recommended for lesser current outputs.

The accompanying illustration gives a good idea of the form of the wedge electrode and of the cylindrical zinc.

The Westinghouse Street of Nations at St. Louis.

An attractive feature of the great Westinghouse exhibits at the St. Louis Exposition is the row of national booths erected and decorated by the different Westinghouse companies of the United States, England, Germany, France, Russia and Canada, in the Palace of Machinery, just to the north of the 14,000-hp service power plant installed for the Exposition by Westinghouse, Church, Kerr & Co., described recently in these pages. Each booth is thoroughly typical of the country it represents, in general style of furnishing and decorations, and the various photographic views hung on the walls show the works of the Westinghouse companies in different parts of the world and prominent Westinghouse installations in each country. Visitors to the different booths are received by interpreters and find the technical periodicals from home placed at their disposal.

The general reception headquarters of the joint Westinghouse exhibit, and the Westinghouse theatre, in which biograph views of the works in the Pittsburg district are displayed at regular intervals throughout the day, are also in the Palace of Machinery, to the south of the big power plant. The discovery of arrangements of this elaborate character for the reception and entertainment of visitors in the Palace of Machinery is an interesting example of the radical change in methods of equipment and operation of great power plants as a result of which the unattractive machinery hall of expositions of former years has given way at St. Louis to a building which ranks in popularity with the other great Exposition palaces of the Fair. Several of the Westinghouse booths were designed under the supervision of the different foreign commissioners to the Exposition, the handsomest being that of the Westinghouse Company, Limited, of St. Petersburg, which has erected also in the Palace of Transportation a pavilion which was constructed at Moscow and shipped complete to the United States, where it has been welcomed as the only Russian building at the Fair. In this latter building, and in the Russian booth in the Palace of Machinery, pretty Russian girls in costly boyarin dress serve Russian tea and suchari to visitors, and a very creditable display is made of Russian art in the furnishings, hangings and ornamental pottery and bric-a-brac.

FIG. 2.—RECEPTION SPACE AND HEADQUARTERS OFFICE.

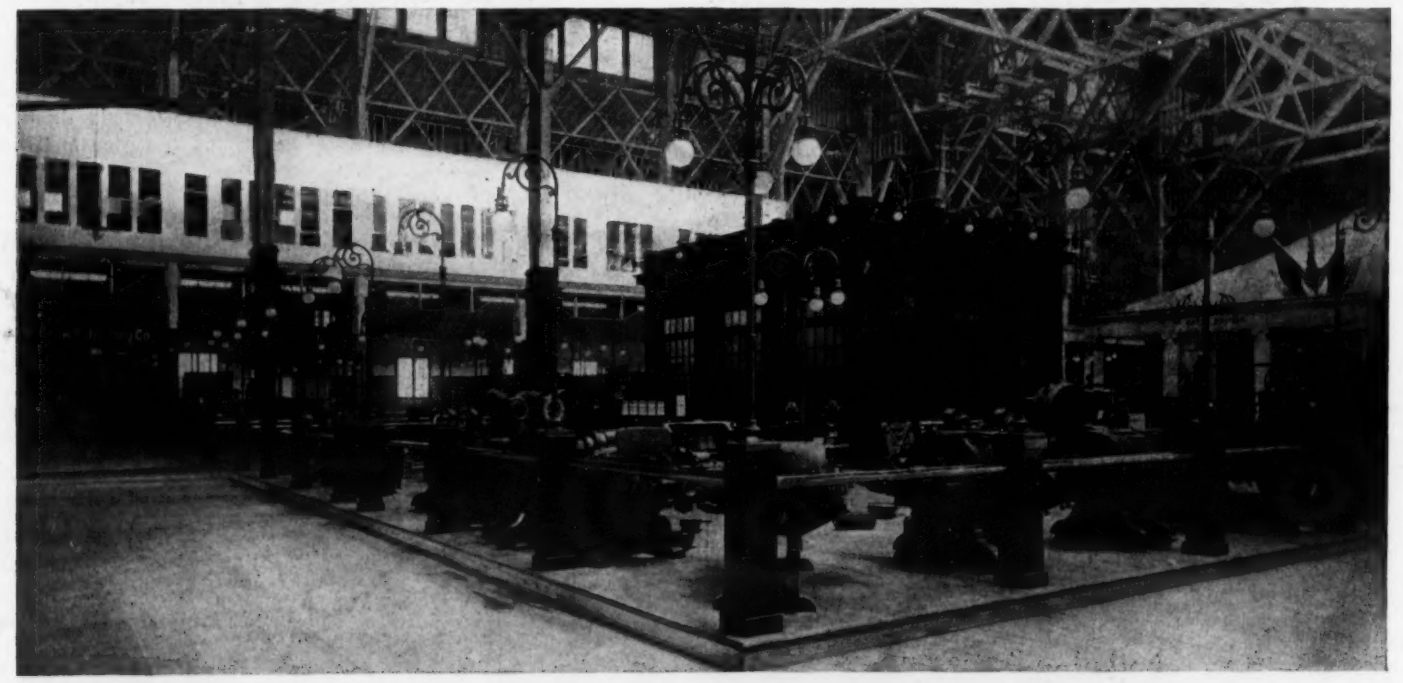


FIG. 1.—GENERAL REAR VIEW WESTINGHOUSE EXHIBIT.

FIG. 3.—UNITED STATES BOOTH.

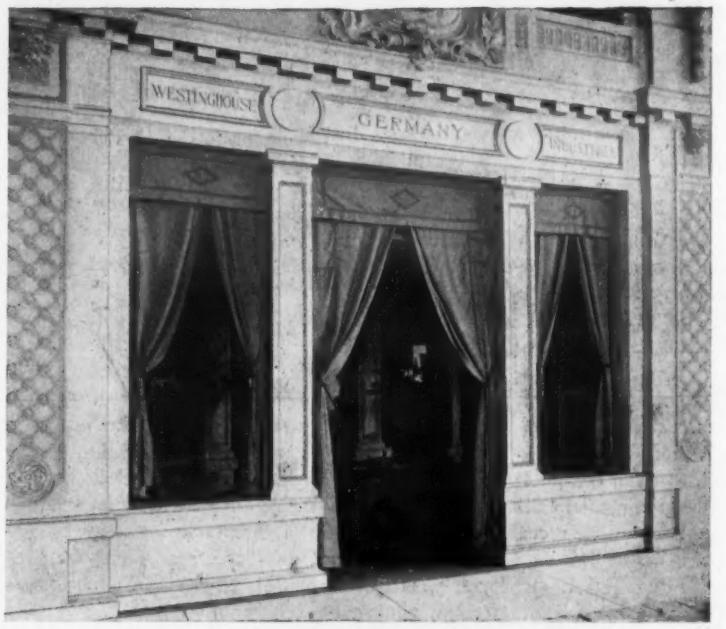


FIG. 6.—GERMAN BOOTH.

FIG. 4.—CANADIAN BOOTH.

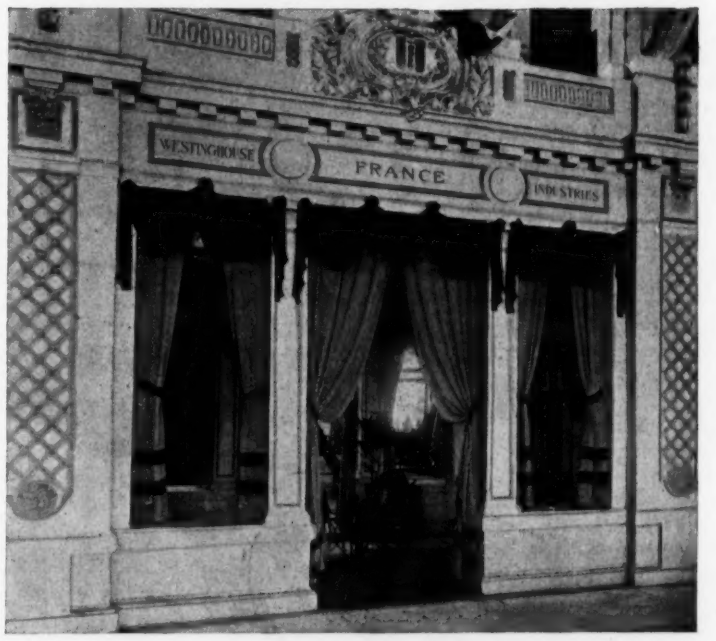


FIG. 7.—FRENCH BOOTH.

FIG. 5.—ENGLISH BOOTH.

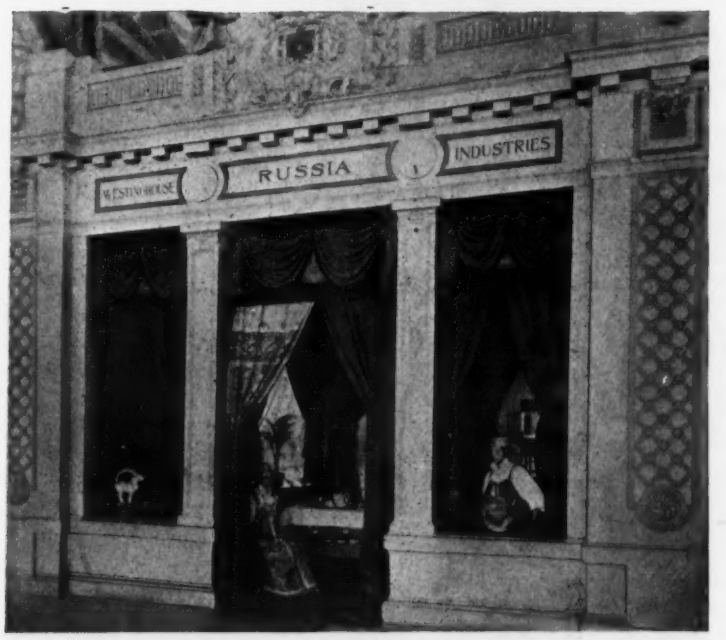


FIG. 8.—RUSSIAN BOOTH.

WESTINGHOUSE STREET OF NATIONS AT THE ST. LOUIS EXPOSITION.

Push Button Telephone.

One of the most convenient and flexible forms of telephonic apparatus is that known as the push button, and a leading type is the Anders, represented formerly in this country by the American Push Button Telephone Company, but now by its successor, the Edmondstone Company. The new concern has introduced sundry changes and modifications in the instruments, looking to their improvement in every respect.

The receivers of the Anders push button telephone are of the watchcase type. They are of the bipolar type, with coils mounted over each pole. The magnets, pole pieces, binding posts, etc., are cast solid in hard rubber composition shells, all of which are formed and cast in steel dies under hydraulic pressure. The coils are wound with silk-insulated, copper magnet wire over split fibre bobbins, then placed over the pole pieces and held in place by a small nickel cap. This arrangement allows the coils to be changed in case of accident. The back of the receiver shell is fitted with a receptacle for the coiling springs and button. A cap is screwed over the receptacle which holds the button in proper position in relation to the springs. The springs are made of German silver and secured to metal lugs with machine screws, the lugs being cast in the back of the receiver shell, as are the receiver magnets, etc. The calling device above explained is free and clear of the receiver working parts and non-interfering.

The transmitter portion is of the solid back type, with self-contained granular carbon and electrode holder of the button type, having a metal diaphragm secured to the front electrode of the button. The granules are of hard polished carbon. The base of the transmitter is fitted with an automatic switch, provided with pin-point springs (angles rounded and not turned short and sharp). In the hard rubber composition base are cast metal lugs fitted with machine screws and washers threaded into the lugs for the transmitter and receiver cord, switch and spring connections, also for the bell, line and battery connections, the base being formed and cast in a steel die, as in the receiver explained.

On the face of the transmitter base is a nickel-finished metal plate

FIG. 1.—PUSH BUTTON TELEPHONE.

with two ear lugs, to engage the grooved metal ring, which is cast over the receiver cap, holding the receiver in place when same is not in use. The placing of the receiver in the ear lugs above explained engages the lever of the automatic switch, which in turn changes the circuit springs on the back of the transmitter base, cutting out the transmitting and receiving circuits, and cutting in the signal bell circuit. There is a small fibre disc fitted in the back of each transmitter base, which disc has a number of holes that correspond to the lugs in the base to which the various wires are to be connected. The holes in the disc are for passing through of the line, battery, bell, wires, etc., before being connected to their respective lugs. The disc

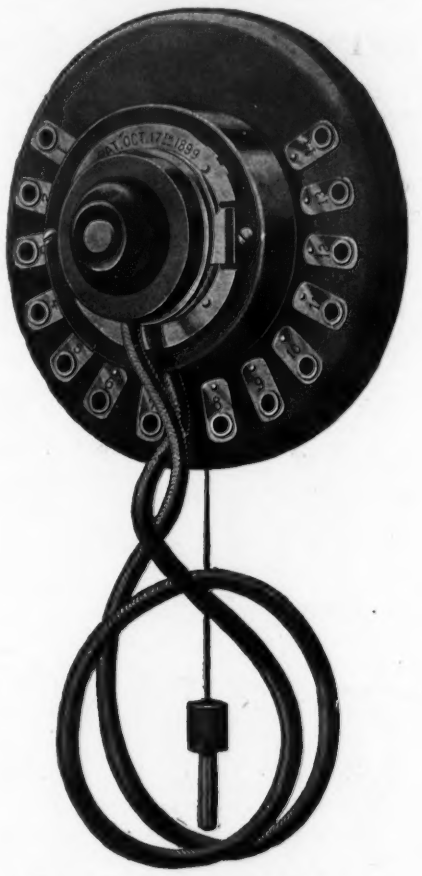


FIG. 2.—PUSH BUTTON TELEPHONE.

is also for protection of the transmitter button, switch, spring connections, etc., and when in place (after the wires are connected) rests on a small inverted rim. The disc is further supported by four small posts, one on each side of the transmitter button and one on each side of the switch springs back of the transmitter base. All screws, lugs and binding posts in the instrument are of brass. The Anders telephone is so designed as not to require readjustment with changes of temperature. The dimensions of the complete telephone are over all, consisting of transmitter, receiver and connecting lugs: Diameter, 3½ in.; depth, 2¼ in.; depth of telephone over all, mounted on intercommunicating switch block of the wall type, is 3¼ in.

The telephones for all systems are identical as to outward appearance, construction and material used and are wired and fitted for the following systems: Straight line, intercommunicating, switchboard or return call annunciator, central station and selective ringing common battery systems.

Stock switchblocks for use in connection with the telephones of the intercommunicating type are of the improved jack and plug style, with binding posts for connections. Springs used in the jack connections are made of the best phosphor-bronze. When the plug is inserted in any of the jacks, the tip engages the tongue of jack springs, which have a double spring bearing, and are not liable to be broken or get out of adjustment through constant use. Switchblocks of mahogany and oak are carried in stock. All exposed metal parts are nickel-plated. The switchblocks are made in one solid piece of thoroughly seasoned wood, of substantial construction, and will not warp. Dimensions: Diameter, 5⅞ in.; depth, ⅞ in. They are fitted with from five to eighteen jack connections. The plug is suspended from the block by a silk cord, which, however, contains no electrical conductor. It is merely attached to the plug to allow it to be suspended from the block when not in use. The plug can be left in any jack and still the station may be called. The plug should be removed when answering calls from another station. The headquarters of the Edmondstone Company are at 105 Chambers Street, and the president is Mr. Burton Thompson.

NEWS OF THE WEEK.

Financial Intelligence.

THE WEEK IN WALL STREET.—The early week war reports had a reactionary tendency on the stock market, but the more pacific aspect of the situation later in the week had a reassuring effect and there was some improvement. There were other incidents which exerted an unfavorable influence upon the market. The statement of earnings of the United States Steel Corporation for the September quarter was rather disappointing, which caused a decline in these issues. The renewal of gold shipments to Paris and the passing of the dividend on Pressed Steel Car common were also among the unfavorable incidents of the week. At the close the market was easier and recoveries were more or less marked. Specialties received little attention, and the traction group was relatively quiet, despite the interest created by the opening of the New York subway. Outside securities on the "Curb" market were fairly active, fluctuations following the trend of the Stock Exchange. Following is a review of the changes in the traction and electric securities, nearly every one of which closed with losses in price. Brooklyn Rapid Transit reached 69, but fell off to 64⅝, and recovered some of the loss, closing at 67⅝, which is a net loss of ¾. Metropolitan Street Railway's closing price was 124, a loss of 3½ points. The highest price of this stock was 129⅝. The opening of the subway apparently had no effect on Manhattan Elevated, as it closed at the highest figure of the week—163¾—this being ¾ point better than the closing price of the previous week. Interborough Rapid Transit closed at 159⅛, with a loss of ⅞ point. Allis-Chalmers common and preferred are fractionally lower, the former closing at 13⅞, and the latter at 60. General Electric ranged between 177¼ and 174, closing at 176½—½ point loss, net. Westinghouse preferred is off 5 points net, closing at 190, and the last quotation of common is 173. Western Union lost 1 point, closing at 91, while American Telephone & Telegraph made a gain of ¾, closing at 144¾. One hundred shares of New York & New Jersey Telephone sold at 157½, which is an advance of ¼ point. Following are the closing quotations of November 1:

NEW YORK

	Oct. 25	Nov. 1		Oct. 25	Nov. 1
Allis-Chalmers Co.	14¼	13⅜	Electric Vehicle	15⅛	14
Allis-Chalmers Co. pfd.	53	54	Electric Vehicle pfd.	21	19
American Tel. & Cable.	91	91	General Electric.	175	173⅛
American Tel. & Tel.	144¾	142	Hudson River Tel.	..	..
American Dist. Tel	26	25	Interborough Rap. Tran.	159⅛	150⅛
Brooklyn Rapid Transit.	67¼	65⅛	Metropolitan St. Ry.	127	122⅛
Commercial Cable.	..	200	N. Y. & N. J Tel.	158	156
Electric Boat.	37	37	Marconi Tel.	..	..
Electric Boat pfd.	70	68	Western Union Tel.	91⅛	90⅝
Electric Lead Reduction	⅛	⅛	Westinghouse com	167	167⅛
			Westinghouse pfd	185	185

BOSTON

	Oct. 25	Nov. 1		Oct. 25	Nov. 1
American Tel. & Tel.	144¾	142⅛	Western Tel. & Tel. pfd.	96	96
Cumberland Telephone.	119	118	Mexican Telephone	1¾	1¼
Edison Elec. Illum.	*251	*250	New England Telephone.	133¾	*133⅛
General Electric	175	..	Mass. Elec. Ry.	12⅛	13
Western Tel. & Tel.	*29	19	Mass. Elec Ry. pfd.	55	55

PHILADELPHIA.

	Oct. 25	Nov. 1		Oct. 25	Nov. 1
American Railways	43¼	40⅛	Phila. Traction	97⅝	97¾
Elec. Storage Battery	72	71	Phila. Electric.	9¼	8¾
Elec. Storage Battery pfd.	72	71	Phila. Rapid Trans.	15⅞	16
Elec. Co. of America	9¾	9⅞			

CHICAGO

	Oct. 25	Nov. 1		Oct. 25	Nov. 1
Central Union Tel.	..	..	National Carbon pfd.	109	109
Chicago Edison.	158	160	Metropolitan Elev. com.	23¼	22
Chicago City Ry.	178	180	Union Traction.	9	9
Chicago Tel. Co.	140	140	Union Traction pfd.	35	37
National Carbon.	*38	37			

* Asked

EFFECTS OF THE NEW YORK SUBWAY.—The financial effects of the operation of the New York Subway have naturally occupied the thoughts of such organs as the *Wall Street Journal*, which says: "In handling as many as 350,000 passengers in a day, while only in partial operation and before its system has become 'limbered up,' the Subway road gives encouragement to those who have calculated a maximum capacity of 180,000,000 per annum for the lines north of the Post Office. This would mean an average of nearly 500,000 per day, but it is not at all impossible that such a figure may yet be reached. Developments so far seem to point to the entire reasonableness of the estimate, but beyond this fact very little bearing on traffic tendencies in this city has been developed by the operations of the new road. New Yorkers have found a new toy and are busy playing with it. When the novelty wears off it will then be instructive to watch the figures of Metropolitan and Manhattan so as to determine how far these may suffer and in this way to estimate the amount of new business created by the underground road. Metropolitan interests say they do not expect the new Subway to have much effect on the traffic of the surface lines. They are naturally averse to giving out figures, which would mean nothing, but they say that already a number of passengers who deserted the surface lines last week have returned. Much of the long haul business will be lost, but this will leave the company less hampered to handle the short haul traffic and in the latter there is expected to be a large increase in spite of, and because of the operation of the underground road. The *Wall Street Journal* on June 14 published a study of the growth of passenger traffic on the surface and elevated lines covering a period of over twenty years and this showed that in certain years, when an increase in facilities stimulated traffic, the growth in number of passengers carried exceeded 10 per cent. As a matter of fact the growth of travel from 1896 down to 1900 suggested that 10 per cent per annum had come to be the normal rate of increase, but traffic then became limited by facilities, so that in 1902, a year of very great prosperity, the growth was only 2.20 per cent. This was undoubtedly due to congestion and the providing of adequate facilities may bring not only the normal growth of traffic but the business which has evidently been lost in the last four years. Under the circumstances it would not be surprising to see an increase of 15 per cent. in the number of passengers carried by the local traction companies in the next twelve months. Such an increase would provide upward of 135,000,000 passengers for the Subway without decreasing the number carried by Metropolitan and Manhattan. A total of 135,000,000 passengers would equal the first estimates of the tunnel's capacity."

MICHIGAN STATE TELEPHONE.—President Jackson, of the Michigan State Telephone Company, estimates that gross receipts for the year 1904 will approximate $2,000,000. During the first few months of this year the maintenance charges, not including cost of extensions, were about $40,000 a month. They have since been increased to $47,000 a month, and in the future it is expected will amount to $600,000 a year. The company now has subscribers to the number of over 62,000, and it is stated new ones are being added at the rate of 1,000 a month. The company has been unusually successful since its reorganization. The reorganization plan provided for an issue of $4,466,000 5 per cent. bonds, $2,285,000 6 per cent. cumulative preferred stock, and $3,500,000 common stock. The year's operations should show a balance of $200,000 over the 6 per cent. on the preferred stock, but this excess will be put back into the property.

DIVIDENDS.—National Carbon directors have declared the regular quarterly dividend of 1¾ per cent. on the preferred stock, payable November 15. The New England Telephone & Telegraph Company's directors have declared the regular quarterly dividend of $1.50 per share, payable November 15. The India Rubber & Gutta Percha Insulating Company of Yonkers declared on October 19 a dividend of 2½ per cent. on the capital stock of the company, payable November 1.

Commercial Intelligence.

THE WEEK IN TRADE.—The general situation in business is satisfactory, and all lines of trade activity and the industries make favorable reports. The cooler weather has stimulated business in general. In the West and South jobbers and wholesalers are reordering. The seasonable conditions are also helping the coal industry, which has been languishing. On the whole collections are good, the South making the best reports in this respect. The present high prices for grain foreshadow a largely increased acreage in 1905. Wheat and corn were stronger on the European war talk during the week, while cotton was weaker in spite of the reports of damage by frost. Railway gross earnings for the first half of October will exceed those of the corresponding period of 1903 by 6 per cent. On the Pacific Coast and in the Rocky Mountain districts trade is fair to good. Lumber is fairly active at all western points and it is also improving at the leading southern markets, but at the leading eastern cities it lacks activity. There is notable strength in pig-iron, advances in price of 25 cents to $1 per ton being reported in the leading markets, and the demand was active at the higher prices. Deliveries running far into 1905 are charged a premium. Bars, plates and structural material are also

more active, especially at the West, and hardware dealers and manufacturers make special note of improved demand. Other metals, notably copper and lead, tend higher. The business failures are fewer in number, *Bradstreet's* reporting 180 during the week ending October 27, as against 227 the week previous and 217 the corresponding week last year.

ELECTRIC HEATING APPARATUS.—These pages gave recently some technical details as to the new electric heating material, "kryptol." Mr. Frank H. Mason, United States Consul-General at Berlin, reports further on the subject as follows: "The exact method of its preparation and the proportions of its ingredients employed are not disclosed by the specifications of its patent, but it is a mixture of graphite, carborundum and clay, so combined as to form a loose granular mass or powder of four grades or degrees of coarseness, which are severally best adapted to different heating operations. Electric heat may be developed by two general methods: The electric circuit may be broken, so that a voltaic arc is formed, and the charge in the furnace is thus heated directly, or the current may be transmitted through a conductor that offers enough resistance to generate heat, which is imparted to other substances by contact. This is the indirect electrical heating system, of which 'kryptol' offers the latest and most interesting example. The property of 'kryptol,' upon which its efficiency depends, is the fact that it offers to an electric current the requisite degree of resistance to generate a high degree of heat without destruction to its own substance. It generates a heat that will raise cold water to boiling point in three or four minutes. Its extreme tractability, by which the temperature can be absolutely regulated by increasing or diminishing the strength of the current or by altering the thickness of the 'kryptol' layer, one or both, renders it applicable to a large variety of practical uses, among which some of the more important are heating street cars, hallways, sleeping and other rooms, and laboratories, where a uniform warmth is essential. Such a heater, which can be put under a car seat or beneath the floor, where it is out of sight, can easily be managed by the conductor or motorman, can generate and maintain indefinitely any desired temperature, and can be used without refilling for weeks together, would seem to solve, technically at least, the problem of street car heating in cold climates. For chemical laboratories the new material has already been adopted by the University of Berlin, the Technical College at Aix la Chapelle, the Imperial Health Office at Berlin, and other State institutions. When used in ovens and heating devices of various patterns it enables the chemist to heat substances to any desired temperature and to maintain an unvarying degree of heat for an indefinite period."

CHITTENDEN POWER HOUSE CONTRACT LET.—The Chittenden Power Company, Vermont, has just awarded the contract for the construction and equipment of its power house on East Chittenden Creek to J. G. White & Co., 49 Exchange Place, New York, which concern will be in the market practically immediately for the purchase of the necessary structural material, machinery, etc. The initial installation will be of 1,200 kw capacity. There will be three generators of 400 kw capacity each, direct-connected to water turbines. The turbines will operate on a head of 215 ft. Considerable construction work has already been completed on the Chittenden project. Large dams and reservoirs have been built, also a 5-ft. steel conduit 8,000 ft. long from the dam to the site for the power house. The energy will be transmitted—high-tension, 13,000 volts—to Rutland, Vt., for general commercial purposes. The transmission line will be about seven miles in length. The Chittenden Company is controlled by the Merchants' Trust Company, of 420 Broadway, New York. Mr. John Bogart, Post Building, is the consulting engineer. French & Bryant, of Boston, are the local engineering experts on the work.

NEW YORK TELEPHONE RATES.—The New York Telephone Company and the New York & New Jersey Telephone Company put a new schedule of toll rates into operation on October 1, by which a general reduction, over their whole territory, of about 20 per cent. went into effect. The reductions range from 5 to 20 cents per call and in some instances the change amounts to as much as 40 per cent. The difference between the pay station rate and the subscribers' rate has at the same time been reduced from 10 to 5 cents uniformly. The aim in the reductions has been to cheapen and popularize the service, as well as to secure readjustment and consistency. Owing to extensions to the system, made from time to time, and from other causes, inequalities have crept into the scale, and at this time this has been rectified as far as possible. The attempt is now made to give an "air-line" rate to outlying districts instead of a "route-rate" such as had frequently prevailed in the past. In other words, a rate is struck for a distance as the crow flies instead of for the distance following the course of the wires about the roads. On the present business, the reduction means a saving to telephone users of $250,000 a year.

BELL TELEPHONE OUTPUT.—The American Telephone & Telegraph Company reports its instrument output for September and the fiscal year to date as follows:

September:	1904.	1903.	Increase.
Gross output	106,305	79,406	26,899
Returned	38,353	33,438	4,915
Net output	67,952	45,968	21,984
From Jan. 1 to Sept. 30:			
Gross output	876,609	812,229	64,380
Returned	374,925	358,831	16,094
Net output	501,684	453,398	48,286
Total outstanding Sept. 30	4,281,201	3,603,718	677,483

NEW YORK CENTRAL SUB-STATION EQUIPMENT.—About the middle of this month the New York Central people are expected to award contracts for the equipment of their first substation power plants of which eight are to be built in various localities along their suburban lines. The first station will be installed with three 1,500-kw rotary converters and a similar number of 1,000-kw machines. Eighteen static transformers will also be contracted for and a motor generator set of about 100 kw capacity. Mr. E. B. Katte, of the New York Central, has the matter in hand.

GENERAL ELECTRIC ARC LIGHTING SYSTEM FOR PUEBLA.—The Mexican General Electric Company, of Mexico City, which represents the interests of the General Electric Company, and of which Mr. D. Mazenet is managing director, has secured a contract from the Compania Anonima del Alumbrado Electrico de Puebla (the Puebla Electric Lighting Company) for a new arc system for street lighting. Upward of 400 constant-current, long-burning, enclosed alternating-current lamps will be used.

CONTRACTS FOR CHICAGO "WHITE CITY."—Contracts will shortly be awarded by the White City Construction Company, 1010 Schiller Building, Chicago, Ill., for a large lot of electrical equipment supplies for the "White City," to be built in Chicago. Mr. Beifield, proprietor of the Sherman House, Chicago, is president of the company. Mr. Paul D. Hornes is general manager. Mr. Edwin C. Boyce, of 302 Broadway, New York, is the architect.

MORELOS WATER POWER PROJECT.—Mexican advices state that Mr. Andres Lefebre is primarily interested in another project to build a water power plant for the purpose of developing energy for general power use. He has applied to the Mexican Government for permission to utilize the waters of the River Amacuzac, located in the district of Tetecala, State of Morelos. It is expected that the plant will have a capacity of upward of 1,000 hp.

EQUIPMENT FOR NEW ORLEANS PUMPING STATION.—Considerable electrical equipment is to be ordered for a new pumping station to be built at New Orleans, La. The engine equipment will include three 600's and two of 225 hp. The generators will be of 150 kw capacity each. At least two machines will be installed. Hering & Fuller, of 170 Broadway, New York, are acting as consulting engineers in the matter.

COPPER EXPORTS.—European copper buying continues active and the home demand is increasing. Exports of copper continue heavy, the shipments to Europe for the twenty-four days of the month aggregating 20,550 tons, or but 19 tons less than the entire exports for last month. It is now thought that October exports may equal those of August, when nearly 25,000 tons were sent hence to Europe.

EQUIPMENT FOR GREENWICH, CONN.—Mr. Edmund C. Converse is to utilize electricity largely for lighting his property at Greenwich, Conn. Mr. James Robert Moore, 156 Fifth Avenue, has been retained as electrical engineer on the matter. He is now inquiring for prices on static transformers, rotary converters, switchboards, etc.

LOWEST BID FOR PUBLIC SCHOOL.—The Commercial Construction Company, 1 Madison Avenue, New York, is the lowest bidder for the electrical equipment for the Public School under construction on Trinity Avenue, between One Hundred and Thirty-fifth and One Hundred and Thirty-sixth Streets. The bid was $6,947.

LIGHTING EQUIPMENT FOR NEW FIFTH AVENUE STORES.—At Sixteenth Street and Fifth Avenue, New York, Mr. Jacob Rothschild, of 31 West Fifty-seventh Street, will build large stores. Considerable electric lighting equipment will be put in. Adams & Schwab, of 7 Clay Street, Baltimore, are the engineers.

CONTRACT FOR APARTMENT HOTEL.—MacKenzie, Quarrier & Ferguson, 114 Liberty Street, have secured the contract for the engines and generators to be installed in the new apartment hotel at 4-8 East Twenty-eighth Street, being built by Mr. L. George Forgolston, 110 West Thirty-fourth Street.

EQUIPMENT FOR BIG APARTMENT HOUSE.—A very large apartment house is to be built at Fifty-third Street and Seventh Avenue, New York, by the Wyoming Apartment Company, of which Mr. Clifford E. Potter, of 137 Broadway, is the president. Considerable electrical equipment will be installed.

INTERESTING EXPORT FIGURES.—Figures issued by the Department of Commerce and Labor through its Bureau of Statistics covering the foreign commerce for the nine months ending with September show that 37.87 per cent. of the exports during that period were manufactures and but 52.04 per cent. agricultural products. Comparing these figures with those of earlier years it may be said that on only two occasions—in the fiscal years 1900 and 1904—have the exports of manufactures formed as much as 30 per cent. of the total exports. In 1900 they formed 31.65 per cent, and in the fiscal year 1904, 31.52 per cent., but in no other fiscal year have they formed as much as 30 per cent. of the total, and at no time have they for a period of any considerable length formed as large a proportion of the exports as has been the case in the nine months ending with September, 1904. The total value of manufactures exported during the nine months ending with September, 1904, is 365 million dollars, against 311 millions in the corresponding months of 1903, 338 millions in the same months of 1900, 145 millions in the corresponding months of 1895, and 113 millions in the corresponding months of 1890. For the single month of September the exports of manufactures were $42,690,501, against $33,244,848 in September of last year. Agricultural products exported in the nine months of 1904 amounted to $502,417,678, against $566,282,378 in the corresponding period of 1903, though in the single month of September the value of agricultural products exported slightly exceeded that of the corresponding month of the preceding year, being in September, 1904, $78,194,486, against $64,185,433 in September, 1903. This increase in the value of agricultural products exported in September, 1904, as compared with September, 1903, is principally due to the exceptionally large exports of cotton in September, which were much above the average of September exportations in earlier years. The share which manufactures form of the exports seems likely in the calendar year 1904 to be greater, and the share which agricultural products form of the total exports seems likely to be smaller than that of any preceding year. In the nine months ending with September, 1904, manufactures formed 37.87 per cent. of the total exports; in 1903 they formed 33.2 per cent.; in 1900, 33.44 per cent; in 1895, 20.68 per cent., and in 1890, 20.21 per cent. of the total exports.

LONG ISLAND RAILROAD.—A special dispatch from Pittsburg says: "The Westinghouse Electric & Manufacturing Company has begun work on multiple control electric motors for 122 cars to be used on the Long Island Railroad, which the Pennsylvania Railroad will operate by electricity. The 122 cars are to be equipped with four motors of 125 hp each. These will haul ordinary trains. As soon as the first order is installed a second contract will be let. The motor cars will be used to haul trains through the Long Island tunnel, and eventually express trains are to be run from Jersey City to Montauk Point. The short runs are to be equipped with motors first. The Pennsylvania company will equip the whole length of the Long Island Railroad immediately, and the new system will be ready for installation in the spring." Westinghouse, Church, Kerr & Co. are the engineers on this work.

ST. PETERSBURG TROLLEYS.—Advices from Pittsburg say: "It can be stated on the best of authority that negotiations have again been opened by a powerful American syndicate for the construction of a modern traction system in St. Petersburg. This same syndicate, a year or more ago, applied for franchises for the building of street railways in the Russian capital, but opposition was raised by the government and the proposition was subsequently abandoned. It is now understood that the Russian syndicate has abandoned its plans, which accounts for the American syndicate again taking them up. Negotiations so far have proven successful. The beginning of the construction of a modern traction system in St. Petersburg is not a question of the immediate future, however. It is anticipated the system will represent an outlay of more than $15,000,000."

ORDERS FOR FUSES.—Mr. F. G. Jones, president of the American Electric Fuse Company, Chicago, recently returned from a trip to the eastern office of the company at New York City. The American Electric Fuse Company's Eastern department headquarters are at 110 to 116 Nassau Street. Mr. Jones reports that the company's Eastern office has recently concluded contracts for over 20,000 pairs of Kaisling protectors, and that the Eastern business is more than double what it was last year, due to the energetic work of W. B. McCurdy, Eastern manager. Mr. Jones also reports the American Electric Fuse Company's sales of protectors during the month of October, at all its offices, has been in excess of 35,000 pairs, and that proposals are under way now for over 100,000 pairs of protectors.

EQUIPMENT FOR ELGIN WATCH PLANT.—The Elgin (Ill.) National Watch Company has just awarded contracts for the equipment of its new power plant which will have a capacity of some 1,500 hp. The Crocker-Wheeler Company, through its Chicago office, secured the contract for the generators. There will be two engines type alternators, 100 r.p.m., low voltage type of 50 kw capacity each. These machines will be direct-connected to horizontal cross-compound condensing engines which will be built by the McIntosh-Seymour Company. There will also be a 200 kw Crocker-Wheeler generator direct-connected to a McIntosh-Seymour engine. The Elgin plant is to be installed under the supervision of Mr. J. Lyons, who was formerly sales manager for the Allis-Chalmers Company, and is now consulting engineer for the Elgin Company.

ELEVATED FIRE ALARMS.—Fire Commissioner Hayes, of New York, has announced that he intends soon to ask for an appropriation to extend a system of fire alarm boxes to the elevated railroad stations. An experimental system has been in use along the Third Avenue Line from Sixty-seventh Street to Hanover Square for several months. Commissioner Hayes will now seek to extend the boxes south on the Second Avenue Line from Hanover Square to South Ferry and up the Ninth Avenue Line to Fifty-ninth Street.

PLANT FOR MANILA.—The new government laboratory at Manila is being fitted up with eight Bossert distributing panel boards and one switchboard. The Bossert Electrical Construction Company, of Utica, N. Y., manufacturers of the above, has made some decided strides of advancement in the lines of panel boards, switchboards and junction boxes, especially the last named, and the government experts are making good use of the increased economy and efficiency effected by these improvements.

MOTORS FOR WATERVLIET ARSENAL.—The Crocker-Wheeler Company, through its New York office, secured recently a contract for 15 motors of 25 hp capacity each for the purpose of driving big gun lathes in the United States Arsenal at Watervliet, N. Y., and has just submitted the lowest tender for the supply of 41 motors to be used for operating other machine tools in the same arsenal. The Crocker-Wheeler bid on the 41 motors was $8,800. They aggregate 480 hp.

SOME CROCKER-WHEELER ORDERS.—The Crocker-Wheeler Company, through its New York offices, Mr. F. B. De Gress, manager, has taken an order for a 100-kw balancer transformer to be installed in one of the New York Edison Company's new plants. The E. J. Manville Machine Company, of Waterbury, Conn., has ordered a 50-kw Crocker-Wheeler belted generator, 125 volts, and switchboard for its lighting plant.

EQUIPMENT FOR CHEMICAL WORKS.—The Naugatuck (Conn.) Chemical Works are to be equipped with 50-kw, engine type, 250 volt Crocker-Wheeler generators arranged for direct connection to Harrisburg-Fleming engines of 75 hp capacity each. The Crocker-Wheeler people also secured the order for the switchboard and for five motors aggregating 38 hp.

EQUIPMENT FOR HOUSTON STREET BUILDING.—Upward of 500 kw of electrical equipment will be put in a new building to be constructed by the Fisher Estate, at 97-107 East Houston Street, New York. Mr. C. O. Mailloux, Bishop Building, is the consulting engineer for the work.

EQUIPMENT FOR ZAHN & BOWLY PLANT.—The Zahn & Bowly Co.'s plate glass mirror plant at Rutherford, N. J., which was burned down last month, is to be rebuilt and electrical equipment will be installed. Mr. E. S. Boyer, of 95 Liberty Street, is consulting engineer for the work.

NO ELECTRICAL EXHIBITION.—The promoters of the proposed International Electrical Exposition in December, at the Madison Square Garden, New York, have decided to abandon the show on account of cost and lack of interest. It is generally felt that St. Louis will suffice for this year.

ELECTRIC COAL-CUTTING PLANT FOR INDIA.—The Jeffrey Manufacturing Company, 41 Dey Street, is installing a large electric coal-cutting plant in the collieries of the East Indian Railway and has recently shipped similar equipment for utilization in South African mines.

THE GRAMATAN INN.—A fair-sized equipment will be put in the Gramatan Inn, which is to be built at Lawrence Park, Bronxville, New York, by Mr. W. V. Lawrence, of 542 Fifth Avenue. Barlow & Bates, of 5 West Thirty-first Street, are the architects.

EQUIPMENT FOR BROOKLYN FACTORY.—A factory is to be built at Sheffield Street, George Avenue and Sutter Avenue, Brooklyn, for which a fair-sized lot of electric equipment will be required. Mr. A. M. Feldman, 120 Liberty Street, is the engineer.

LIGHTING EQUIPMENT FOR HARVARD.—The Harvard University Medical School is to have an electric lighting plant which will consist of a 200-hp American Ball duplex compound engine direct connected to a 125-kw generator.

DIRECTORY OF ELECTRICAL ASSOCIATIONS, SOCIETIES, ETC.

(Published first issue of each month.)

AMERICAN ELECTROCHEMICAL SOCIETY. Secretary, S. S. Stadtler, 39 S. 10th St., Philadelphia. Next meeting, Boston, 1905.

AMERICAN ELECTRO-THERAPEUTIC ASSOCIATION. Secretary, Dr. C. E. Skinner, New Haven, Conn.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Secretary, Ralph W. Pope, 95 Liberty Street, New York. Meetings, last Friday each month.

AMERICAN RAILWAY, MECHANICAL & ELECTRICAL ASSOCIATION. Secretary, Walter Mower, 12 Woodward Avenue, Detroit, Mich.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS. Secretary, G. W. Tillson, Brooklyn, N. Y.

AMERICAN STREET RAILWAY ASSOCIATION. Secretary, T. C. Pennington, 2020 State Street, Chicago.

ASSOCIATION OF EDISON ILLUMINATING COMPANIES. Secretary, W. S. Barstow, New York City and Portland, Ore.

ASSOCIATION OF RAILWAY TELEGRAPH SUPERINTENDENTS. Secretary, P. W. Drew, Milwaukee, Wis. Next meeting, Chattanooga, Tenn., third Wednesday in May, 1905.

CANADIAN ELECTRICAL ASSOCIATION. Secretary, C. H. Mortimer, Toronto, Ont. Next meeting, Montreal, 1905.

COLORADO ELECTRIC LIGHT, POWER & RAILWAY ASSOCIATION. Secretary, George B. Tripp, Colorado Springs, Col.

CONNECTICUT STATE STREET RAILWAY ASSOCIATION. Secretary, E. W. Poole, Bridgeport, Conn. Annual meeting in November.

ENGINE BUILDERS' ASSOCIATION OF THE UNITED STATES. Secretary, J. I. Lyle, 39 Cortlandt St., New York. Next meeting, New York City, December 2 and 3, 1904.

ELECTRICAL ASSOCIATION OF NORTH DAKOTA. Secretary, S. J. Fuller, Larimore, N. D.

ELECTRICAL CONTRACTORS' ASSOCIATION OF NEW YORK STATE. Secretary, F. Fish, Rochester, N. Y.

ELECTRICAL TRADES SOCIETY (Member National Electrical Trades Association). Secretary, A. P. Eckert, 39 Cortlandt Street, New York. Board of Directors meets second Friday of each month.

ILLINOIS STATE ELECTRIC ASSOCIATION. Secretary, H. E. Chubbuck, LaSalle, Ill.

INDIANA PUBLIC UTILITIES ASSOCIATION. Secretary, A. M. Barron, South Bend, Ind.

INDEPENDENT TELEPHONE ASSOCIATION OF THE UNITED STATES OF AMERICA. Secretary, Frank G. Jones, 48 West Jackson Boulevard, Chicago.

INDEPENDENT TELEPHONE ASSOCIATION OF SOUTHERN INDIANA. Secretary, E. W. Landgrebe, Huntingburg, Ind.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS. Secretary, Frank P. Foster, Corning, N. Y.

INTERSTATE INDEPENDENT TELEPHONE ASSOCIATION. Secretary, E. M. Coleman, Louisville, Ky. Next meeting, Chicago, Dec. 13, 14 and 15, 1904.

IOWA ELECTRICAL ASSOCIATION. Secretary, W. S. Porter, Eldora, Ia. Next meeting, Dubuque, Ia., April, 1905.

IOWA TELEPHONE ASSOCIATION. Secretary, C. C. Deering, Des Moines, Ia. Next meeting, second Tuesday in March, 1905.

KENTUCKY INDEPENDENT TELEPHONE ASSOCIATION. Secretary, James Maret, Mount Vernon, Ky.

MAINE STREET RAILWAY ASSOCIATION. Secretary, E. A. Newman, 471 Congress Street, Portland, Me.

MASSACHUSETTS STREET RAILWAY ASSOCIATION. Secretary, Charles S. Clark, 70 Kilby Street, Boston, Mass. Meets second Wednesday of each month, except July and August.

MICHIGAN ELECTRIC ASSOCIATION. Secretary, J. E. Davidson, Port Huron, Mich.

NATIONAL ARM, PIN & BRACKET ASSOCIATION. Secretary, J. B. Magers, Madison, Ind.

NATIONAL ELECTRICAL CONTRACTORS' ASSOCIATION OF THE UNITED STATES. Secretary, W. H. Morton, 44 Whitesboro Street, Utica, N. Y.

NATIONAL ELECTRIC LIGHT ASSOCIATION. Secretary, Dudley Farrand, Newark, N. J.

NEW ENGLAND STREET RAILWAY CLUB. Secretary, J. H. Neal, 101 Milk Street, Boston, Mass. Meets last Thursday of each month.

NEW YORK ELECTRICAL SOCIETY. Secretary, G. H. Guy, 114 Liberty Street, New York.

NORTHWESTERN ELECTRICAL ASSOCIATION. Secretary, T. R. Mercein, 85 Michigan Street, Milwaukee, Wis.

OHIO STREET RAILWAY ASSOCIATION. Secretary, Chas. Currie, Akron, Ohio.

OHIO ELECTRIC LIGHT ASSOCIATION. Secretary, D. L. Gaskill, Greenville, Ohio.

OHIO SOCIETY OF MECHANICAL, ELECTRICAL AND STEAM ENGINEERS. Secretary, C. J. Miller, Canton, Ohio. Next meeting, Canton, Nov. 18, 1904.

OLD TIME TELEGRAPHERS AND HISTORICAL ASSOCIATION. Secretary, John Brant, 195 Broadway, New York. Next meeting, New York, N. Y., 1905.

PACIFIC COAST ELECTRIC TRANSMISSION ASSOCIATION. Secretary, G. P. Low, 600 Rialto Building, San Francisco, Cal.

PENNSYLVANIA STATE INDEPENDENT TELEPHONE ASSOCIATION. Secretary, H. E. Bradley, 135 South Second Street, Philadelphia, Pa.

SOUTHWESTERN ELECTRICAL AND GAS ASSOCIATION. Secretary, F. E. Scovill, Austin, Tex.

STREET RAILWAY ACCOUNTANTS' ASSOCIATION OF AMERICA. Secretary, W. B. Brockway, 40 Morris Street, Yonkers, N. Y.

STREET RAILWAY ASSOCIATION OF THE STATE OF NEW YORK. Secretary, W. W. Cole, Elmira, N. Y.

VERMONT ELECTRICAL ASSOCIATION. Secretary, C. C. Wells, Middlebury, Vt.

WESTERN SOCIETY OF ENGINEERS, Electrical Section. Secretary, J. H. Warder, 1737 Monadnock Block, Chicago, Ill.

General News.

THE TELEPHONE.

HUNTSVILLE, ALA.—The Huntsville, Guntersville & Gadsden Telephone Company has been bought by Lawrence Cooper, trustee for the creditors.

SANTA ROSA, CAL.—The West Side Telephone Company, of Healdsburg, has been incorporated by M. V. Frost, H. S. Goddard, John McClish and others. Capital, $6000.

WASHINGTON, D. C.—The National Telephone & Electric Company has been incorporated with a capital stock of $100,000. The incorporators are B. F. Wasson, Ernest W. Porter and E. Richard Shipp.

COEUR D'ALENE, IDA.—The Interstate Telephone Company has applied to the Council for a franchise to construct a telephone system in this city.

GRANTSBURG, IND.—The Temple Telephone Company has been incorporated with a capital stock of $5000. Joseph Blevins is president of the company.

INDIANAPOLIS, IND.—The Tilden Mutual Telephone Company, of Tilden, Hendricks County, has filed articles of incorporation with the Secretary of State. The capital stock is $5000.

CHEROKEE, IA.—The Spring Brook Rural Telephone Company has been incorporated with a capital of $1000.

DES MOINES, IA.—The Gaza & Sutherland Telephone Company has been incorporated in O'Brien County, with a capital of $600.

SHELDON, IA.—The Sheldon Commercial Club is getting signatures for telephones for an independent exchange in this place.

DUBUQUE, IA.—The Iowa Telephone Company has decided to place its wires underground, and will spend about $600,000 on general improvements to its property.

REINBECK, IA.—The Iowa Telephone Company proposes several improvements in this vicinity. New offices are to be opened at Hudson and Berlin. The new circuits will be as follows: Marshalltown to Reinbeck; Waterloo to Grundy Center via Reinbeck; Dysart to Reinbeck, making Reinbeck a switching station.

DETROIT, MICH.—The Shore Line Telephone Company has been incorporated with a capital stock of $50,000.

MARSHALL, MICH.—The Marshall Telephone Company has sold its exchange to the Citizens' Telephone Company of Grand Rapids.

CALHOUN, MICH.—The Calhoun County Telephone Company has opened up a new territory in southern Michigan and northern Indiana in addition to the regular toll points. The new points reached in Michigan are Fairfax, Nottawa, White Pigeon, Constantine, Coldwater, Quincy, Batavia, Bethel, Matteson, Girard; and in Indiana: Orland, Angola, La Grange, Rome City, Kendallville, Goshen, Elkhart, South Bend, Mishawaka, Fort Wayne, Albion, Lafayette and Butler.

MORRILL, MINN.—The Morrill Rural Telephone Company has been incorporated.

BRUNO, MINN.—Mr. Sherrick, of Willow River, is constructing a telephone line from that place to Bruno.

WESTBROOK, MINN.—The Southwestern Minnesota Telephone Company contemplates installing a local exchange here.

HELENA, MONT.—The Rocky Mountain Bell Telephone Company contemplates putting in a conduit system at a cost of $50,000.

RED LODGE, MONT.—The City Council has denied the application of the Rocky Mountain Bell Telephone Company for a franchise to establish an exchange here.

BUTTE, MONT.—The Rocky Mountain Bell Telephone Company is building new exchanges in Missoula and Billings. They are also building an exchange at Sand Point and extending the line to Hope, Ida., and will be into Missoula in a short time. Wires are being strung from Butte to Salt Lake City.

HATTIESBURG, MISS.—The Cumberland Telephone & Telegraph Company has been granted a telephone franchise here for the period of twenty-five years.

ST. LOUIS, MO.—The Fosterburg & Upper Alton Telephone & Telegraph Company, a farmers' company, is preparing to build its lines into Alton.

KANSAS CITY, MO.—The Kansas Telephone Construction Company has been incorporated with a capital stock of $75,000. The incorporators are Jas. S. Brailey, Jr., Toledo, Ohio; Edward L. Barber, Wauseon, Ohio; C. Snyder, W. C. Polk and Hugh C. Ward.

JEFFERSON CITY, MO.—The Sweet Springs Telephone Company, of Sweet Springs, has been incorporated with a capital stock of $20,000. The incorporators are B. H. Dickson, R. Sam Hays, Charles K. Smith, J. F. Coulter, Henry Park, J. R. Smith and W. L. King.

RENO, NEV.—The work of constructing a telephone system here has been commenced by the Sunset Telephone Company. The estimated expenditure is $35,000.

MACDOUGALL, N. Y.—The MacDougall Telephone Company has been incorporated with a capital of $5000. The directors are Addison Balbridge, Alexander Balbridge, of MacDougall, and R. C. Allen, of Romulus.

LITTLE FALLS, N. Y.—The American Construction & Trading Company, of Elyria, Ohio, has purchased a half interest in the Interstate Telephone Company, of this city, for the purpose of making a link in a cross-state long-distance independent telephone service. Irving H. Griswold, of Albany, represents the new purchasers.

SYKESTON, N. D.—The long distance telephone line from Sykeston to Bowdon has been completed.

CHARDON, OHIO.—The Chardon Telephone Company has increased its capital stock from $25,000 to $50,000.

WILLOUGHBY, OHIO.—The Kirtland Telephone Company has increased its capital stock from $2500 to $5000.

CENTERBURG, OHIO.—The Central Ohio Telephone Company has increased its capital stolk from $10,000 to $50,000.

SALEM, OHIO.—The Salem Township Rural Telephone Company will build a line south and southwest of Leetonia and in the vicinity of Franklin Square, which will probably connect with the Columbiana Company's lines.

DARRIN, OKLA.—In the new town proposed to be built, the company having the project in hand contemplates spending $5000 on a telephone line, and $10,000 on an electric light plant.

PORTLAND, ORE.—A strike of the telephone girls employed by the Pacific States Telephone & Telegraph Company has been declared by the local union, as a result of the refusal of the company to recognize the union and the ruling that affiliation with the union must be renounced by all employes.

NEW PHILADELPHIA, PA.—The Tuscarawas County Telephone Company has completed plans for renewals and improvements on the county plant, that will involve the expenditure of over $60,000. The entire plant is to be re-cabled and a general renovation of the whole system is planned.

ALLENTOWN, PA.—Th Consolidated Telephone Companies of Pennsylvania, with a system of exchanges extending from McKeesport to Norristown, it is stated, have entered into negotiations for the sale of their properties to the United States Telephone Company, whose plan is to establish a trunk line from New York, via Philadelphia, to Chicago. Under the plan the United States Company is to come into possession of the independent exchanges at Norristown, Reading, Allentown, Scranton, Wilkesbarre, Mauch Chunk, Harrisburg, Altoona and McKeesport, all having connections with the Keystone, of Philadelphia, and also with the independent Knickerbocker, of New York, by way of cross-Jersey lines.

COLUMBIA, S. C.—The Lexington Telephone Company, of Lexington, has been incorporated with a capital stock of $10,000. J. E. Kaughman is the president.

HUDSON, S. D.—The system of the Hudson Telephone Company is being extended.

HIGHMORE, S. D.—The Hyde County Telephone Company will install an exchange here.

ABERDEEN, S. D.—The Steninger Telephone Company has been incorporated with $50,000 capital.

PIERRE, S. D.—Work has been commenced on a telephone system on Cheyenne River reservation. Two lines to be built, one from White Horse camp on the northwestern part of the reservation, and the other from Cherry Creek, both touching the main agency near Forest City.

LETCHER, S. D.—A number of farmers residing west of this place have organized what will be known as the Storia Telephone Company and are rapidly completing the work of extending the lines through the rural communities. Four lines belonging to the company are being constructed, with Storia postoffice as the central point. It is proposed to extend the lines northwest to the town of Lane, and southeast and southwest to the farming communities in those directions. One of the lines extends to Letcher.

FORT WORTH, TEX.—A telephone merger has been effected whereby the independent exchanges at Brownwood, Goldwaite, Coleman and Ballinger are brought into the new company. This company also takes in the long distance line between Lampasas and San Angelo, with several branch lines. Additional long distance lines are to be built as soon as possible.

EL PASO, TEX.—It is announced that the Colorado Telephone Company, which now operates a long-distance telephone line into Las Vegas, N. M., from the North has decided to extend that line as far south as Socorro, touching Santa Fe, Albuquerque, Cerillos, Belen and other towns along the route. From Belen the company will extend the line to Las Cruces, N. M., where it will connect with the telephone line from El Paso, thereby giving El Paso a new long-distance telephone outlet to the north.

SPOKANE, WASH.—The Pacific States Telephone Company is installing "emergency," or one-way telephones in this city. It expects to use 2000 instruments for this service.

WAITSBURG, WASH.—The Waitsburg Rural Telephone Company will incorporate with J. W. Morgan, president; Gustave Volmer, vice-president; W. B. Brooke, secretary, and A. W. Phillips, treasurer.

LA CROSSE, WIS.—The line of the Tri-State Telephone Company has been extended to La Crosse

WASHBURN, WIS.—President C. A. Lamoreaux, of the Independent Telephone Company, is making arrangements for the building of a new telephone line into the Engoe district.

RACINE, WIS.—All telephone, telegraph and electric light wires in the city are to be ordered underground on streets paved or to be paved. The fire and police wires are also to go under at a cost of $7000.

CITY OF MEXICO, MEX.—The Mexican Government is using the telephone with great success in its campaign against the hostile Yaqui Indians. A complete telephone system has been constructed in the turbulent territory of the State of Sonora, under direction of the Secretary of War, and the movements of the warring bands of Indians are promptly reported to the military authorities. In this manner many Indians have been captured and their plans for raids frustrated.

NAPLES, ITALY.—The Italian ministry of posts and telegraphs has received authority in parliament to establish telephone connections between Brescia and Bergamo, Lecco and Bergamo, Cremona and Piaenza, Genoa, Pisa and Leghorn, Naples, Foggia and Barletta, Naples, Reggio, Calabria and Messina.

ELECTRIC LIGHT AND POWER.

HAZEN, ARK.—The City Council has granted a franchise to the Hazen Electric Light & Telephone Company.

HELENA, ARK.—The question of a municipal water and lighting plant is now being considered. Hugh Martin is mayor.

GUERNEVILLE, CAL.—The Guerneville Light Company has been incorporated by W. P. Turner, O. O. Cobb and W. A. Turner, with a capital of $25,000.

SAN FRANCISCO, CAL.—The Board of Directors of the Mutual Electric Light Company has elected H. H. Taylor, the Pacific coast representative of D. O. Mills, to the position of president of that corporation. W. R. Summer hayes, who remains vice-president and general manager, expects to have the new electric power station at the corner of Spear and Folsom Streets in operation by next Christmas. New 2200-volt transformers are being installed on the distributing system to conform to the change from 125-cycle to 60-cycle generators. The company has a large number of new contracts signed for service from the new plant.

DENVER, COL.—It is stated that the Denver Gas & Electric Company will extend its system to Berkeley, Harman and the Park Hill addition.

WASHINGTON, D. C.—Bids will be received until Nov. 15 by the Bureau of Supplies and Accounts, Navy Department, Washington, for furnishing at the Navy Yards at Norfolk, Va., Charleston, S. C., and Port Royal, S. C., a quantity of motor-drive outfits for Bement-Niles horizontal punch, insulators, conduit, dynamo cable, Davidson & Worthington steam pumps, motor driven service pumps, double acting pumps, etc. H. T. B. Harris, Paymaster-General, U. S. A.

WAYNESBORO, GA.—The citizens have voted to issue bonds for the construction of an electric light plant.

CLARKSVILLE, GA.—J. H. Hicks, Mayor, writes that the town expects to install water works and an electric light plant next year, and would be glad to receive suggestions as to the probable cost, etc., of the two plants.

BOISE, IDA.—Bids for the construction of a dam and electric power plant have been advertised for by the Barber Lumber Company.

GRANGEVILLE, IDA.—The electric light plant in this city was partially destroyed by fire, and it will be several weeks before the plant can be re-equipped and the service resumed.

GENESEO, ILL.—The directors of the Geneseo Electric Light Company have voted to issue $8500 bonds to put in new machinery and boilers.

GRANITE CITY, ILL.—The Granite City Gas Light & Fuel Company has been incorporated with a capital of $200,000. Incorporators: Wm. F. and Henry F. Niedringhaus.

McHENRY, ILL.—The McHenry Heat, Light & Power Company has been incorporated with a capital of $20,000. Stephen Reynolds, D. C. Doe and W. D. Ball are the incorporators.

FRANKFORT, IND.—Francis M. Ingler has purchased the Larue & Patterson electric lighting plant in this city and announces that he will expend $20,000 in improvements. Mr. Ingler has ordered plans prepared by a competent engineer and the work of installing the betterments will begin soon.

WAVERLY, IA.—Prof. G. W. Bissell, of Ames, has been engaged to advise the Council on the construction of an electric light plant. F. H. Munger is City Clerk.

HUTCHINSON, KAN.—The City Council has under consideration the question of constructing a municipal electric light plant.

WICHITA, KAN.—The City Council has granted the Citizens' Electric Light, Heat & Power Company a franchise for an electric light and heating plant.

PADUCAH, KY.—S. A. Fowler, Secretary of the Board of Public Works, writes that it is proposed to install a new electric plant, to cost $20,000. H. H. Humphrey, of St. Louis, Mo., is engineer.

HOLYOKE, MASS.—The Board of Aldermen has passed the order providing for an appropriation of $30,000, to be used for reconstructing and enlarging the electric light station.

WAYNE, MICH.—The citizens have voted to issue $8000 bonds for public lighting. W. S. Reynolds, of Detroit, has been retained as engineer to have charge of constructing the plant.

WINONA, MINN.—H. M. Lamberton has secured a franchise for a power and lighting system.

MINNESOTA LAKE, MINN.—There is talk of constructing an electric light plant at this place.

EUPORA, MISS.—J. T. Marshall, City Clerk, writes that W. T. Givin will construct an electric light plant here.

BOZEMAN, MONT.—The Gallatin Light & Power Company and the People's Electric Light Company have effected a consolidation through an interchange of stock of the two companies.

HAVRE, MONT.—H. W. Turner, of Butte, has purchased the plants of the electric light and telephone companies. He has decided to extend the lighting system, and also put in a plant for steam heating of buildings.

BRUNSWICK, MO.—It is reported that H. K. Palmer, Kansas City, will prepare plans and superintend the construction of an electric light plant here.

LOUISIANA, MO.—The Louisiana Gas & Electric Light Company filed a statement last week showing that it had made an increase in its capital stock from $50,000 to $100,000, all the increase paid.

ST. LOUIS, MO.—The Board of Public Improvements has announced a public hearing on November 1 on the matter of compelling the various wire-using companies to use jointly one line of poles, instead of maintaining separate

lines in the same street or alley. An effort will be made to frame an ordinance regulating the use of the same line of poles by different companies.

OMAHA, NEB.—The City Council has under consideration the placing of all the overhead electrical wires of the franchised corporations underground in the underground district.

PITMAN, N. J.—The New Jersey Southern Gas & Electric Company has made an assignment, Mr. D. O. Watkin, of Woodbury, being appointed receiver. It is stated that the company was unable to recover from the damage done to its plant by heavy rainstorms.

WATKINS, N. Y.—Bonds to the amount of $20,000 have been sold, to be used for the construction of a municipal electric light plant.

TANNERSVILLE, N. Y.—The Tannersville Electric Light & Power Company has been organized, and will be ready to supply both Hunter and Tannersville by June 1, 1905.

WEST POINT, N. Y.—It is stated that the Secretary of War at Washington has rejected all bids opened on Oct. 6 by the Quartermaster, U. S. A., for engines, generators and switchboard for the West Point Military Academy. The lowest bid received was that of the Sterling Boiler Company, of Barberton, Ohio, for $30,600.

MT. OLIVE, N. C.—The Standard Electric Company, of Charlotte, has secured the contract for constructing an electric light plant for the Mt. Olive Electric Light & Power Company.

PROSPECT, OHIO.—George S. Wysall, J. S. Webb, W. A. Black, A. L. Neereamer and J. W. Petty, all officers of the Columbus, Delaware & Marion Railway Company, have incorporated the Prospect Electric Light & Power Company. The company has bought the local lighting plant and eventually will combine the equipment with that of a sub-station for the electric railway which passes through the town.

HOOD RIVER, ORE.—The construction of a 50-foot dam and the installation of an electric power plant for the lighting of the city is an enterprise being promoted by Leslie Butler, J. L. Henderson and H. F. Davidson, of this city.

UNION, ORE.—The Eastern Oregon Development Company is preparing to establish an electric power plant on the Big Minam River, Chief Engineer Brown, of the company, having already completed surveys for the plant. The construction of an electric railway is also planned.

CHATTANOOGA, TENN.—The Chattanooga Electric Company has submitted a bid to the Board of Public Works for electric lighting. Under a five-year contract, the company offers to furnish street lights at $6.49 per month, or $77.88 per year each, and under the ten-year contract at $5.79 per month, or $69.48 per year. The present contract is $7.08 per month, or $85 per year for each light.

SPANISH FORK, UTAH.—Local promoters have before the City Council a petition for a franchise to construct and operate an electric lighting plant, the Spanish Fork River being the source from which the power will be derived. The proposed plant will supply this city and Payson with electric light, and will be installed at an estimated cost of $60,000.

OGDEN, UTAH.—The American Falls Canal & Power Company, of Ogden, has been incorporated to operate in Bingham and Logan counties; capital, $500,000. Lyman Skeen, president; J. J. Brummitt, secretary.

BRADFORD, VT.—C. A. Prouty, of Newport, has purchased the mill property and water power of B. S. Hooker at Bradford, and a controlling interest in the Bradford Electric Lighting Company. He proposes to develop the power in the spring.

SEATTLE, WASH.—Kilbourne & Clark, one of the largest electrical supply firms in the northwest, have discontinued the electrical wiring business as a result of the strike of the electricians comprising the Seattle union of that craft.

SEATTLE, WASH.—The Seattle Electric Company announces that beginning November 1 it will make an eight-cent reduction in its rate of lighting charges. The present rate is 20 cents per kw-hour for the first 30 hours of maximum demand and 5 cents per hour for the excess. The proposed reduction will make the rate 12 cents per kw-hour for the first 60 hours' maximum demand and 3 cents for the remainder of the month.

CENTRALIA, WASH.—Owing principally to the low stage of the water in the river which in part furnishes the power for the electric lighting of this city, the lights of late have not been up to the standard guaranteed by the contractor. On account of the failure of the lights, the City Council imposed a fine of $150 upon the contractor, who claims that he is living up to his contract and refuses to stand the fine. As a result he closed down his plant and left the city in total darkness.

MILWAUKEE, WIS.—City Engineer Poetsch has contracted with R. G. Hunt & Company, of Chicago, Ill., to make an estimate as to the probable cost of the construction and maintenance of a municipal light plant, under a special resolution passed by Common Council.

VICTORIA, B. C.—The Victoria Power Company has been formed, with authority to issue bonds to the amount of $750,000, to divert the water from Koksilah River to Shawnigan Lake and convey it to Mill Bay. Energy obtained will be used for industrial lighting and street railway service in Victoria and Esquimault.

PUEBLA, MEX.—The Compania Anonima del Alumbrado Electrico de Puebla will make improvements to its plants at Puebla to cost about $30,000 gold. Arc lamps are to be used in place of the incandescent lamps which are now in use for lighting the streets of the city.

GUAYMAS, MEX.—Hon. Ramon Corral, vice-president of Mexico, who owns the electric light plants at Guaymas and in the city of Hermosillo, has given orders for extensive improvements to these two plants to be made. The proposed improvements will cost about $50,000.

THE ELECTRIC RAILWAY.

COLUSA, CAL.—Articles of incorporation will be filed soon by a new company for the purpose of constructing an electric railway from St. Johns, on the west side of the Sacramento River, to Colusa, a distance of 31 miles, with a connecting branch from Butte City to Chico, a distance of 20 miles. The company will be known as the Northern Electric Railway & Navigation Company, with a capitalization of $3,000,000.

SAN FRANCISCO, CAL.—The shareholders of the Chico Electric Railway Company held a special meeting in this city October 17, when it was voted to authorize the creation of a bonded indebtedness of $200,000 in 5 per cent., thirty-year gold bonds. Major Jones, of Oroville, Cal., is one of the prominent stockholders. It is the intention to proceed at once to construct a local electric railway system in Chico, connecting also with the adjoining manufacturing town of Barber and other suburbs.

ATLANTA, GA.—An amendment has been granted by Secretary of State Philip Cook to the charter of the Atlanta Northern Railway Company, which will permit the company to build its line from a point on the eastern side of the Chattahoochee River, near Collins' Bridge, to a connection with the Marietta Street line of the Georgia Railway & Electric Company just outside the city limits of Atlanta.

BOISE, IDA.—W. M. Donaldson and H. P. Ustick have been granted a year's extension of time upon their franchise for the construction of an electric railway over certain roads of the county.

NAMPA, IDA.—E. H. Dewey, the local capitalist, is promoting a project for the establishment of an electric railway to traverse the region between this city and Boise, and has interested numerous Boise capitalists in the enterprise. The plans have progressed to the extent that surveys for the road have already been made.

LITCHFIELD, ILL.—The Litchfield Traction Company has been incorporated with $5000 capital. Directors: M. J. Buscher, G. L. Settlemire and others.

AURORA, IND.—E. W. Swarthart and Harry R. McMullen, of this city, are interested in a plan to build an electric railway between Aurora and Rising Sun.

HAMMOND, IND.—The Kensington & Eastern Railroad Company has filed articles of incorporation to build an electric railway in Cook County, Ill. The directors are J. C. Weiling, S. F. Andrews and others.

DES MOINES, IA.—The St. Joseph & Marysville Electric Railway is to be extended.

IOLA, KAN.—E. V. Crouch, president of the Kansas Southern Electric Railway, has announced that a new line will be built from Iola to Chanute.

MAYSVILLE, KY.—An electric railway is projected from this city to Germantown via Washington, opening up the richest section of Mason County. Hon. Evan Lloyd, of Germantown; Col. John Duley, Hon. C. L. Sallee and Thomas A. Davis, of Maysville, are interested.

SPRINGFIELD, MASS.—The Springfield Street Railway Company has been granted a franchise to extend its line.

BENTON HARBOR, MICH.—The City Council has granted J. B. McMichael a franchise for an independent entry and terminal facilities for his interurban line.

MT. CLEMENS, MICH.—The Detroit & Bay City Traction Company has applied for a franchise to run through the city. The application has been referred to a Council committee.

OWOSSO, MICH.—Representatives of the Owosso & Corunna Electric Railway are seeking a franchise from Vernon village and townships to extend the line through Vernon to Durand.

BATTLE CREEK, MICH.—It is reported here that the Michigan Central will change its Battle Creek and Sturgis branch to an electric line. A company has been organized to build an electric railway from this city to Coldwater, and it is stated that, to head off this proposed interurban, the Sturgis branch will be equipped with electricity.

CLAREMONT, N. H.—At a special meeting of the stockholders of the Claremont Railway & Lighting Company it was voted to increase the capital stock of the company by $85,000, subject to the approval of the railway commissioners, to pay the floating debt of construction.

ELIZABETH, N. J.—The City Council has passed an ordinance granting the Essex Cross Railway Company permission to construct a line through the city.

SCHENECTADY, N. Y.—The Schenectady Railway Company is securing the right of way for the extension of its line.

ROCHESTER, N. Y.—The proposition to construct a trolley road from Rochester to the southern tier counties is, apparently, rapidly taking definite form. E. E. Shutt, of this city, is one of the promoters in the enterprise.

HIGH POINT, N. C.—All of the counties through which the High Point Interurban Traction Company proposes to operate have granted the franchises applied for.

MARION, OHIO.—C. W. Bechtel, J. W. Coulter, J. B. Rinehart, Howard Green, F. A. Beery, Adam Krider and others, of Galion, are promoting an electric railway from Galion to Marion by way of Edison. A considerable portion of the right of way has been secured.

YOUNGSTOWN, OHIO.—Final surveys are being made for the route of the Youngstown & Canton Railway and the right of way is being secured. The Osborn Engineering Company, of Cleveland, is the engineer for the road.

PATCHOGUE, L. I., N. Y.—The State Railroad Commissioners have granted the required certificate to the South Shore Traction Company, showing the necessity for the building and maintenance of such a road, and work is to be started as soon as possible. The new line, when completed, will connect

Brookhaven, which is 5½ miles east of this place, with New York City, through Jamaica and Brooklyn. It will pass through all south side villages.

CINCINNATI, OHIO.—The Cincinnati, Georgetown & Portsmouth Railway Company has elected officers as follows: A. W. Comstock, president; W. R. Todd, vice-president; H. E. Sawyer, treasurer; A. O. Herzog, secretary, and F. F. Dinsmore, attorney. These, with Samuel Tappin, John Nichols and W. J. Thompson, are directors.

SANDUSKY, OHIO.—J. C. Parker, promoter of the Sandusky, Clyde & Tiffin Electric Railway, is sanguine that the road will be built next year. He claims that the only portion of the right of way not yet secured is along the county property south of the city. The main line will extend from Sandusky to Tiffin, and there will be a branch line from Castalia to Fremont.

SPRINGFIELD, OHIO.—The recently organized Springfield, South Charleston, Washington C. H. & Chillicothe Traction Company has increased its capital stock to $1,500,000. It is announced that a prominent New York company has underwritten the bonds for that amount. Work of grading is being pushed by several construction gangs and track laying is progressing. Material for the entire line from Springfield to Chillicothe is being purchased and a great deal of it is being delivered. It is expected to have more than 40 miles of road in operation by the middle of next summer.

ALLENTOWN, PA.—The Carbon Street Railway Company, the successor to Mauch Chunk, Lehighton & Slatington Street Railway Company, which was sold at receiver's sale on April 12, organized by the election of Harry C. Trexler, president; J. M. Dreisbach, secretary and treasurer; J. M. Dreisbach, Andrew S. Keck, Hugh E. Crilly, A. C. Godschalf, Thomas A. Snyder and Reuben J. Butz, directors. The company starts without debts and no bonds will be issued.

WINCHESTER, VA.—Henry A. Pressey, Washington, D. C., has been retained as chief engineer for the Winchester & Washington Electric Railway Company.

ASHLAND, WIS.—The Ashland Street Railway Company contemplates extending a line to the city of Washburn.

PRISON CITY, N. M.—The Auburn & Northern Electric Railway Company will build a line from Prison City to Port Byron.

NEW INDUSTRIAL COMPANIES.

THE OCONEE WATER, LIGHT & POWER COMPANY, of Walhalla, S. C., has been incorporated with a capital stock of $5000.

THE PENN ELECTRIC COMPANY, of New York, has been incorporated with a capital stock of $1000. The directors are Charles Bruning, L. H. Amsler and Knud Maerch.

THE NISSON ENGINEERING COMPANY, of Phoenix, Ariz., has been incorporated with a capital stock of $1,000,000. The incorporators are R. L. Spencer, H. C. Seigman and W. P. Nolan.

THE MUTUAL ENGINEERING COMPANY, of New York, has been incorporated with a capital stock of $5000. The directors are J. B. Smith, William Horton and Percy Leonard, of New York.

THE LIVINGSTON MANOR ELECTRIC COMPANY, of Livingston Manor, N. Y., has been incorporated with a capital stock of $32,000. The directors are F. M. Woolsey, L. E. Woolsey and W. F. Scudder, of Hancock.

THE EXPERT STEAM HEATING & ENGINEERING COMPANY, of New York, has been incorporated with a copital stock of $2500. The directors are D. E. Whitlock, N. F. Jones and P. B. Scarff, of New York.

THE DOUGLAS PHONOGRAPH COMPANY, of New York, has been incorporated with a capital stock of $25,000. The directors are C. V. Henkel, E. E. Franchot, of New York, and Martha V. Douglas, of East Orange, N. J.

THE OSBORN-MORGAN COMPANY, Cleveland, Ohio, electrical engineering, has been incorporated with a capital stock of $10,000. The incorporators are W. M. Duncan, W. B. Whiting, C. E. Sanders, Frank S. Whitcomb and F. R. Denison.

THE KLEINBURG MANUFACTURING COMPANY, Chicago, Ill., has been incorporated with a capital of $250,000 for manufacturing gas and steam engines and electrical machinery. Elmore Kleinberg, Harry R. Thompson and Arthur J. Chisam are the incorporators.

THE TERRITORIAL ENGINEERING COMPANY has been incorporated at Oklahoma City, Okla., with a capital stock of $25,000, for the purpose of mining, manufacturing, construction of railroads and light, power and gas plants. The incorporators are F. H. Packham, M. L. Cunningham and others.

THE ELECTRIC AUTO TRANSFER COMPANY, with a capital stock of $25,000 full paid, has been incorporated at St. Louis, Mo. The incorporators are Joel C. Slaughter, of Dallas, Tex.; Horace W. Beck, Charles N. Coen and William S. Walker, of Webster Groves; Charles R. Skinner and Merritt M. and Clarence B. Beck, of St. Louis.

THE VALLEY IMPROVEMENT COMPANY, Defiance, Ohio, has been incorporated with a capital of $10,000. The incorporators are H. D. Bokop, John F. Frost, T. T. Ansbery, M. W. Steinberger and Henry B. Harris. It it proposed to construct a dam to secure water power for sale for all purposes and to do all things incident to such business.

EDUCATIONAL.

MECHANICS INSTITUTE, ROCHESTER.—An electrical construction shop is about to be equipped at the Mechanics Institute, Rochester, N. Y., where students will construct storage batteries, dynamos and motors as well as simpler electrical machinery, while making a thorough study of their design, theory and operation.

AUTOMOBILE SCHOOL.—The West Side Young Men's Christian Association, 318 West 57th Street, New York, has started an automobile school in co-operation with the Automobile Club of America. The object is to teach owners, prospective owners and chauffeurs the theory and practice of automobiles and automobiling. Three courses of automobile enginering will be taught, namely: 1. Popular illustrated lectures; 2. Design and draughting; 3. Operative work. The school opened on Oct. 31, 1904, and will issue certificates to chauffeurs who pass the practical examination given at the close of the operative course. The tuition fees are moderate.

OBITUARY.

MAX OSTERBERG.

MR. MAX OSTERBERG.—We have to announce the sad news of the death of Mr. Max Osterberg, the well-known consulting electrical engineer and expert, which took place at his home at Brighton Heights, Staten Island, on Wednesday, October 26. Mr. Osterberg had an apoplectic stroke during the middle of July, which necessitated his immediate retirement from business. He took to his bed and was progressing favorably, due to his splendid physical constitution, when another stroke resulted in his peaceful death on the above-mentioned date. Mr. Osterberg was born on June 12, 1869, at Frankfurt-on-the-Main, Germany. He was the son of Henry Osterberg, a well-known manufacturer and financier. Young Osterberg received his primary education in the Realschule of his place of birth, came to America when sixteen years of age and soon after his arrival found employment as an office boy in a large manufacturing house, where he remained until his twenty-second year, having in the meantime not only secured advancement to the position of bookkeeper and general manager, but qualified himself for entrance to Columbia University, New York. After an attendance of only two years at Columbia he was graduated with high honor and the degree of E. E. From 1894 to 1896, Mr. Osterberg made a special study of Hertzian waves and wrote a work on thermo-dynamics, which became a text book in many leading colleges in this country, including Columbia. He was awarded an honorary fellowship, and in 1896 received from Columbia the degree of A. M. During the Chicago World's Fair, Mr. Osterberg was editor of the Proceedings of the Electrical Congress. He was editor of *Electrical Power* until 1896 and was associated at that time with Mr. T. A. Edison on his X-ray investigations, being the fourth man on record in this country to obtain a satisfactory picture, and in X-ray photography he achieved marvelous perfection. He adhered to this work so zealously during this period that he frequently went without food and sleep, characteristic of his method of pursuing scientific investigations. In the Fall of 1896 Mr. Osterberg started in business for himself as consulting electrical and mechanical engineer. He acted as consulting engineer for the Cunard Steamship Company, of New York, engineered the electrical construction work of the first electrical show at New York, and has drawn up specifications for installation in many leading churches, office buildings, factories, clubs, etc., while his services have been in considerable demand for trolley testing and inspecting, and other accurate scientific and engineering tests. Mr. Osterberg has given much attention to lecturing on electricity and kindred subjects, and he had a record of more than 900 lectures, which he had delivered before scientific societies and his classes at the Y. M. C. A. Mr. Osterberg had rare power of calculating chances and his great energy and perseverance, as well as his personal suavity of mannr, account for his influence among his fellow professionals, and his well deserved personal popularity. He was a member and former vice-president of the New York Electrical Society, a member of the American Institute of Electrical Engineers, the American Mathematical Society, the American Electro-Chemical Society and an honorary member of the National Society of Electro-Therapeutics. Mr. Osterberg was also a member of several charitable and social organizations and director in a number of industrial companies.

MRS. HELEN E. BLITZ, president of the Bishop Gutta Percha Company, died at her residence in Westfield, N. J., on Saturday, Oct. 22. She was the widow of Signor Antonio Blitz, the celebrated ventriloquist and sleight-of-hand performer, who surprised and delighted large audiences in all parts of this country for 30 years or more prior to 1870. About that time he retired to Philadelphia and spent his remaining years which ended in 1876, in exhibitions for various charities in the Quaker City. The late Mrs. Blitz was a second wife and having no children of her own, upon the death of her husband came to New York and made her home with Mrs. S. C. Bishop, who was an own cousin and had ever been a most intimate friend. Mrs. Blitz's maiden name was Eaton, and her mother's name was Adams, both parents being of noted Boston families, and during her whole life the culture and common sense characteristic of good New England blood were well exemplified by her. Mr. Samuel C. Bishop had died four years prior to the death of Mr. Blitz, leaving the care of his estate to his widow, who being in poor health was very fortunate in having the assistance of Mrs. Blitz who was obliged to take the helm. Upon the death of Mrs. Bishop in 1881 Mrs. Blitz by the collateral wills of Mr. and Mrs. Bishop, who had no direct heirs, inherited one-quarter of their estate, including the Bishop Gutta Percha Works, and upon the organization of the present Bishop Gutta Percha Company she was elected a director. She became its president in 1894 and held that office until her death. She had latterly been interested with relatives in the construction of a beautiful new home at Westfield, N. J. The home was just completed and furnished and Mrs. Blitz was watching some last work by the decorator when she was stricken with apoplexy and did not regain consciousness. Her body was cremated at Fresh Pond crematory as directed in her will.

PERSONAL.

MR. H. F. SANVILLE, of H. F. Sanville & Company, of Philadelphia, was a visitor in New York last week.

MR. L. R. NASH, formerly head of the Stone & Webster engineering department at Boston, is now local manager of the Savannah Electric Company.

MR. JOHN W. CORNING, electrical engineer with the Boston Elevated Railway Company, has recently returned from a two-weeks' visit to Colorado.

MR. C. W. BUNNELL, JR., formerly of the Lackawanna Steel Company, has been appointed treasurer of J. G. White & Company, vice Mr. Chester Griswold.

MR. JOHN C. R. COOTES has resigned his position as electrical engineer for the Pacific Coast Company to accept a similar position with the Daly Reduction Company, Ltd., of British Columbia.

MR. C. J. FIELD, of the Field-Foulks Company, 29 Broadway, New York City, has again entered the arena as a consulting engineer, as a separate department from the conduit business of that concern.

MR. ARTHUR D. BUTTERFIELD, formerly assistant roadmaster of the L division of the Boston Elevated Railway Company, is now with the Old Colony Street Railway Company, his headquarters being at Brockton.

MR. GEORGE HILLMAN WHITFIELD, electrical and mechanical engineer of the Virginia Passenger & Power Company, of Richmond, Va., was married Oct. 26, at Baltimore, Md., to Miss Laura Merryman.

SIR WM. CROOKES, F.R.S., is the subject of the Bullock Electric Manufacturing Company's card calendar for November. He was born in 1832, and has been for fifty years a leading figure in the world of invention and scientific research.

DR. LIONEL FLEISCHMANN, who was formerly on the staff of the Union Electricitaats Gesellschaft, of Germany, and is now with the "Allgemeine" since the consolidation, is again visiting this country and will spend some four or five weeks here.

MR. W. M. BELL, superintendent of the Conshohocken Electric Light & Power Company, of Conshohocken, Pa., is installing a new 150-kw Stanley generator and Stearns engine. He is also busy extending lines and erecting a new switchboard. The plant is one of those owned by the Electric Company of America.

PROF. A. H. DUFF, of the department of physics in the Worcester Polytechnic Institute, gave an interesting talk on "Wireless Telegraphy" before the Worcester Branch of the Worcester Polytechnic Institute Alumni Association on Oct. 25. The gathering was held at the Bay State House, a dinner being served at 6.30 P. M. Seventy-three graduates of the Institute were present.

MR. R. STEUART ERSKINE, of London, one of the members of the Institution of Electrical Engineers visiting this country, returned home this week after a prolonged stay in the City of Mexico. Mr. Erskine is actively connected with electric lighting in London at the West End. He was accompanied by his wife, who is an author of various books on art and a welcome contributor on art subjects to the magazines and periodicals.

MR. G. MARCONI was treated with much consideration while visiting the national capital last week. The President was much interested in his descriptions of the latest developments in long-distance wireless telegraphy, about which he asked many questions, showing that he has been paying much attention to this phase of the question, as it applies to the necessities of the United States navy and army. During his visit Mr. Marconi was the guest of the Italian embassy, as we noted last week.

MR. C. A. SCHIEREN, JR.—A special dispatch from Bristol, Tenn., of October 29, says: "Burglars entered the bedchamber of C. A. Schieren, in Bristol, at three o'clock this morning and carried away several gold watches and jewelry, including pearls and diamonds valued at more than $1,200. Mr. Schieren is a son of former Mayor Charles A. Schieren, of Brooklyn, and resides here as manager of his father's Southern tannery interests. One of the watches taken had recently been presented to Mr. Schieren by his father."

MR. HENRY L. DOHERTY has been elected a member of council of the American Gas Light Association. His electrical friends echo these remarks about him in the *Progressive Age* of November 1: "The election of Henry L. Doherty as a member of council will give general satisfaction. A more indefatigable and zealous worker in the cause of strengthening and building up not only association work, but the whole field of gas engineering practice, cannot be found. He is thoroughly alive to the merits as well as the shortcomings of association work and has convictions as well as the courage to stand by them. He should be a valuable addition to the council of the American Association."

ADDRESSES WANTED.—The American Institute of Electrical Engineers wants to know the addresses of the following-named foreigners who visited the States during the summer in connection with the International Electrical Congress: Wilhelm Durnkrantz, Baron Wolfgang Ferstel, C. F. Milliken, H. L. Riseley, E. Ziehl. Considerable mail addressed to the above-named persons has accumulated at the secretary's office, 95 Liberty Street, New York, and should be forwarded to the addressees without further delay. Secretary Pope will be grateful for any information regarding the whereabouts of these men.

NEW INSTITUTE MEMBERS.—The following new associate members in the American Institute of Electrical Engineers were elected on October 28: Austin, Arthur Oswin, inspector, California Gas & Electric Corporation, 131 S. California St., Stockton, Cal.; Barton, Edward J. M., assistant electrical engineer, Panama Railroad Company and Electric Light Company, Panama, R. de P.; Barton, George Lewis, erecting engineer, Westinghouse Electric & Mfg. Company, 716 Board of Trade Building, Boston, Mass.; Bell, Ulysses S., assistant electrician, Southeastern Tariff Association, Atlanta, Ga.; Bergman, Sven Robert, assistant engineer, General Electric Company, 26 Mall St., Lynn, Mass.; Brosius, Frank R., Columbus Railway & Light Company, 410 King Ave., Columbus, Ohio; Carpenter, Eugene, generating department, Boston Suburban Electric Company, Newton, Mass.; Clay, John Allen, electrical engineer, Hecla Mining Company, Burke, Ida.; Coseo, George Edward, foreman, electrical department, Solvay Process Company; res., 123 Erie St., Syracuse, N. Y.; Crane, Albert Sears, principal assistant engineer, Sanitary District of Chicago, 1003 Security Building, Chicago, Ill.; Davis, Charles Woolsey, sales engineer, Southwestern Electrical Engineering & Construction Company, 177 Main St., Dallas, Texas; Donaldson, John Muir, commercial engineer, British Thomson Houston Company, 29 Murray Road, Rugby, Eng.; Eberhardt, Elmer Gould, partner, Eberhardt Brothers Machine Company, 113 Orchard St., Newark, N. J.; Enslen, Eugene Flynn, Jr., electrical engineering assistant, Ford, Bacon & Davis, 2501 5th Ave., Birmingham, Ala.; Ferguson, William Augustine, electrical engineer Mexican Light & Power Company, Ltd., Mexico City, Mex.; Goddard, Walter Thompson, electrical engineer, Locke Insulator Mfg. Company, Victor, N. Y.; Gould, Frederick Seabury, draftsman with Charles E. Waddell, Albemarle Park, Asheville, N. C.; Gunter, Emil, tester, General Electric Company, Schenectady, N. Y., Pierson, Fla.; Harper, Raymond H., secretary and manager, Harper Electric Company, 330 W. Creighton Ave., Fort Wayne, Ind.; Harris, James Wilfrid, engineer, British Westinghouse Electric & Mfg. Company, Ltd., Manchester, Eng.; Hayden, Virgil, electrical engineer, Frontier Telephone Company, 64 Emerson Place, Buffalo, N. Y.; Hild, Frederick Waldorf, assistant engineer, General Electric Company, 1047 Monadnock Building; Hoar, William John, engineering department, American Telephone & Telegraph Company, 15 Dey St., New York City; Iyer, T. K. Arunachela, operator, Cauvery Power Electric Scheme, Champion Reefs, Mysore, So. India; Kelley, Walter Stuart, electrical engineer, Narragansett Electric Lighting Company, 170 Westminster St., Providence, R. I.; Kidder, Lee Hobart, assistant electrical engineer. Co. Explatodora de Las Furzas Hidro Elect. de San Ildefanso, Mexico City, Mex.; Koiner, C. Wellington, general superintendent, Madison County Gas & Electric Company, Oneida, N. Y.; Loveless, Wait Reynolds, student, General Electric Company, 145 Franklin St., Lynn, Mass.; McClellan, Ross St. John, electrician, 66 Union Ave., Schenectady, N. Y.; McGeorge, Harold, general manager, Electric Controller & Supply Co., Cleveland, Ohio; McNulty, Peter Cuttino, engineering department, Westinghouse Electric & Mfg. Company, Wilkinsburg, Pa.; Milford, George Roscoe, installing engineer, Northern California Power Company, Whitmore, Cal.; Milmow, Albert, electrical engineer, "La Electricista" with Grant & Company, Manila, P. I.; Nordstrum, Lauren Dale, instructor, Purdue University, Lafayette, Ind.; Osborn, Harold, department of machinery, World's Fair, St. Louis, Mo.; Petersen, Oluf Gottlieb, electrical and mechanical engineer, Stearns Laboratory Company, Stearns, Ky.; Raymond, Francis, 3d, Western sales manager, General Incandescent Arc Light Company, 1412 Marquette Building, Chicago, Ill.; Reed, William Edgar, designing engineer, Westinghouse Electric & Mfg. Company, Pittsburg, Pa.; Reynolds, H. H., chief electrical engineer, Kilburn & Company, 4 Fairlie Place, Calcutta, British India; Ripple, Paul W., electrical engineer, Lehigh Valley Railroad, South Bethlehem, Pa.; Spies, Albert, editor, *Cassier's Magazine* and *The Electrical Age*, New York City; Towle, George Carroll, constructing engineer, McCulloch Company, Mattoon, Ill.; Waters, Herman Bierce, switchboard operator, Missouri River Power Company, Canyon Ferry, Mont.; Whiteley, Raymond, draughtsman, Underground Electric Railways Company of London, 20 Glebe Place, Chelsea. S. W., Eng.

Trade Notes.

WINDOW LIGHTING.—The H. T. Paiste Company, Station D., Philadelphia, Pa., has gotten out a pamphlet entitled "Window Lighting," a copy of which will be sent to anyone interested in that subject.

ELECTROBESTOS.—The application of electrobestos to incandescent lamp socket rings is the subject of the latest *News Bulletin* of the H. W. Johns-Manville Co. The rings made from this material are fireproof and practically non-breakable and will withstand a breakdown test of 2000 volts.

THE MOLINE INCANDESCENT LAMP COMPANY, of Moline, Ill., has opened a branch office at 105 Chambers Street, New York, with E. E. Anderson as manager, and a branch office in New Orleans, La., with S. J. Stewart as manager. Other offices will be opened as rapidly as proper representatives can be secured.

THE UNITY MANUFACTURING COMPANY has recently been organized in Springfield, Mass., to manufacture and sell appliances pertaining to the economic use of and improvements in heat, light and power. L. J. Richards, of Springfield, is president, and E. H. Barringer, of Chicago, treasurer. The capitalization is $20,900.

THE C. W. HUNT COMPANY, of West New Brighton, New York, has been particularly successful at the World's Fair, two of its three exhibits securing highest wards, the third not entered. The Hunt "Industrial" railway received the gold medal for narrow gauge railways, and the electric storage battery locomotive built by that company received the silver medal, being the highest award for this type of locomotive.

SECOND-HAND ELECTRICAL MACHINERY.—Bargain list No. 3 of Joseph H. Thompson, Jr., 11 Broadway, comprises seven pages of entries of second-hand direct-connected units, compound and simple engines, boilers, generators and motors from 110 to 550 volts, 60-cycle and 133-cycle alternators and motors, arc dynamos and railway motors and cars. A special entry refers to a 700-kw, 13,200-volt, three-phase, 25-cycle alternator with switchboard and exciter.

G. I. ARC LAMPS.—Forming part of a discount sheet, the General Incandescent Arc Light Company gives a list of its various catalogue publications, the backgrounds of the lists being in colors corresponding to the colors of the several series of catalogues. These series comprise arc and incandescent lamps (white), switchboard appliances (pink), wiring and general appliances (orange), motors and equipments (yellow), panels (blue), and miscellaneous (nile green).

THE MILLS ELECTRIC COMPANY, Peoria, Ill., has been formed to engage in the sale of electrical supplies and in electrical contracting. In the near future it may add a department for making switchboards, fixtures, and some specialties, the exact nature of which will be determined later. Mr. Leroy A. Mills is president and manager of the company, and Mr. L. C. Henkle is the secretary. Mr. W. H. Taylor, of Peoria, is a stockholder, and Mr. Winslow Evans is one of the incorporators.

THE BURT MANUFACTURING COMPANY, of Akron, Ohio, which makes the well-known Cross oil filters, has developed what is probably the largest export business in its line in the world. It has recently made a shipment of 5 oil filters to its agency at Helsingfors, Finland; 3 large shipments to its representative in Havana, Cuba; also 4 filters to customers at Valparaiso, Chile. Besides shipping two of its 8-inch exhaust heads for the use of the United States Government at Seattle, Wash., it has recently made a shipment of 16 exhaust heads and 9 oil filters to supply its English trade. It also reports the sale of 3 oil filters to its agency at Calcutta, India.

BRISTOL RECORDING METERS.—The September catalogue of the Bristol Company, Waterbury, Conn., is a very comprehensive exposition of the well-known products of this concern. The pamphlet measures 9 in. by 12 in., which size gives opportunity for excellent display of illustrations of the company's recording volt, ampere and wattmeters. The illustrations of the charts taken from these instruments are full size and accurately reproduced. Complete tables give code words, pricelist and other information regarding these instruments, also specimen sections of charts used for different classes of work. At the back dimension diagrams are given, also diagrams of connections.

"INDEPENDENT TELEPHONE PRACTICE."—We have received a copy of "Independent Telephone Practice," compiled by Messrs. I. J. Kusel and A. E. Dobbs. This booklet contains valuable information for the independent exchange electrician and operator. While the subject matter contained has been in a measure treated before, there has been no book compiled that places this matter and data thus together, in a manner so simple that it may be easily understood by the layman. It is the simplicity and instructiveness of the book that will make it valuable. The Eureka Electric Company, of Chicago and Genoa, Ill., is distributing this, with its compliments, to any company or individual desiring a copy. It is decidedly worth securing by anyone interested.

MECHANICAL DRAFT.—The increasing demand for mechanical draft continues, not only in the United States but in other countries. The power plant for the new shops of the Mexican Central Railway Co., at Aguascalientes, Mexico, contains a Sturtevant induced draft apparatus consisting of two steel plate fans, each driven by a Sturtevant vertical engine. Each fan is capable of maintaining a draft pressure in the flue connection of each boiler equal to ¾ of an inch of water when handling all the gases of combustion, burning 35,000 lbs. of coal per hour with a flue temperature of 600° F. The ring oiling fan bearings next to the fan are water-jacketed to prevent overheating. A counterbalanced sliding damper permits either fan to be cut off from the flues or both may be operated at the same time. The engines are provided with regulating valves which automatically control the steam pressure.

ALLIS-CHALMERS COMPANY, Milwaukee, and its electrical department, known as the Bullock Electric Manufacturing Company of Cincinnati, has won several grand prizes, which are the highest awards of the St. Louis Exposition, in steam, electrical and mining engineering. Its famous "Big Reliable" engine, the largest ever exhibited, won a grand prize, as did the huge Bullock electric generator driven by it. The electric grand prize also covered all the Bullock alternating and direct-current generators and motors and rotary converters. A gold medal was also awarded for the Bullock multiple voltage system of controlling motors. The big Allis-Chalmers engine and Bullock generator are among the most notable features of the World's Fair. They supply current for the world-famous decorative lighting of the Exposition buildings and grounds. This great power unit is 40 ft. high and weighs 720 tons, and has not cost a cent for repairs since the day the steam was first turned on. The Allis-Chalmers mining machinery exhibit also won a grand prize. In this exhibit were the Gates gyratory rock and ore breakers, and Overstrom concentrating tables, and other machinery known among miners the world over. The winning of the highest electrical honors in the face of competition is significant of the progress which has been made by this great engineering concern of the West, which has for many years been pre-eminent as steam engine builders. Nine Allis-Chalmers engines, each more than twice as large as the "Big Reliable," will operate the New York Subway. Five of them are working now. The others are on their way to New York. Each weighs 1,500,000 pounds and requires 50 large freight cars for its transportation.

AN ICE EXHIBIT.—There is only one exhibit of refrigerating and ice-producing machinery on the Exposition grounds at St. Louis. This has been installed by the Ice & Cold Machine Company near Intramural Station, No. 9 University Way. An ice machine consists essentially of a pump handling carbonic acid gas, hydrogen sulphide, air, or some other gaseous medium, and driven by a steam engine or other prime mover. In the present case a steam engine is used, which, in order to obtain condensation (distilled water) for making ice, as well as to improve the engine economy, is run condensing, exhausting into an 1800 square foot Worthington surface condenser. The tubes of this condenser are of seamless drawn brass and the tube heads are carefully drilled and tapped to receive screw glands. The latter are adjustable and permit of free movement of the tubes during expansion or contraction, and can be readily removed to permit replacing the packing. The cooling water for these condensers is taken from the lagoon. To remove the air which always accumulates in a surface condenser a Worthington wet vacuum pump of the duplex type is used, having 10-in. cylinders, 14-inch air cylinders and 10-in. stroke. The peculiarity of the wet vacuum pump is that the air pistons are always submerged, preventing leakage and doing away with the necessity for lubrication. The steam piston valves used in this pump are perfectly balanced, requiring little or no oiling, making it possible to operate the pump with very little attention.

CONTINUOUS RAIL JOINT.—The Jury of Awards of the Louisiana Purchase Exposition has awarded the gold medal for rail fastenings to the Continuous Rail Joint Company of America, for its display made in the Transportation Building of its rail joint products. The exhibit shows various types of rail joints produced by patented machinery controlled by the company in this country. The careful manufacture and perfect fit, giving three points of contact in one piece of metal, thus forming a rail joint of two symmetrical pieces, obtained as a result of these patents, has secured for them both from steam and electric railroads the appreciation of the great value of this device. Further acknowledgment of the merits of the continuous rail joint is shown in the fact that over 20,000 miles of railroad track has been equipped within the past ten years. The company owns and operates the Albany Iron & Steel Works, at Troy, N. Y. It has on the market to-day types of joints for tee rails and girder rails that are made of rolled steel. It also manufactures step or compromise joints to connect rails of different sections and obtain a perfect surface and gauge for abutting rails. These are made of cast steel. This company is now bringing out a new type of insulated rail joint for the market. The development of the business has made it necessary to organize a company in Canada for the exclusive use of Canadian patents originally owned by it, and another corporation in London, England. This appliance has alredy been introduced in many foreign countries. The general offices of the company have always been at Newark, N. J.

Record of Electrical Patents.

UNITED STATES PATENTS ISSUED OCT. 25, 1904.

[Conducted by Rosenbaum & Stockbridge, Patent Attys., 140 Nassau St., N. Y.]

772,914. SWITCH; Charles C. Badeau, Schenectady, N. Y. App. filed Sept. 16, 1901. A switch adapted to be operated automatically or manually and which will indicate by which of these two modes it has been thrown.

772,927. APPARATUS FOR THROUGH RINGING ON TELEPHONE TRUNK LINES; Henry M. Crane, New York. App. filed Feb. 17, 1902.

772,936. CUT-OUT SWITCH FOR TELEPHONES; James R. Harris, Trenton, Mo. App. filed June 23, 1904.

772,944. ELECTRICAL TESTING APPARATUS; William J. Kyle, Philadelphia, Pa. App. filed Nov. 19, 1902. A portable apparatus comprising means for "tone testing" without the intervention of the operator at the exchange-station.

772,950. ALTERNATING-CURRENT MOTOR; Maurice Milch, Schenectady, N. Y. App. filed Feb. 10, 1904. (See Current News and Notes.)

772,959. MEDICAL BATTERY; Leon W. Pullen, Philadelphia, Pa. App. filed Feb. 18, 1904.

772,963. ELECTRIC CIGAR LIGHTER; William Roche, Jersey City, N. J. App. filed Jan. 29, 1904. Electric spark produced for igniting alcohol torch.

772,967. SAFETY FUSE; Edward L. Simons, Alden, Pa. App. filed June 24, 1903. A construction of inclosing case for a fuse strip whereby the strip may be readily renewed when burned out.

772,985. INSULATED RAIL JOINT; George A. Weber, New York, N. Y. App. filed June 8, 1904. A combination of rails, side-bars and rail chair aiming at complete insulation for the rail and locking the rail ends against upward movement as wheel pass from one rail to another.

772,987. CONTACT FOR TROLLEYS; Thomas F. Wetton, Newark, Ohio. App filed Feb. 4, 1904. A contact shoe is pivoted to the pole in such manner as to bear against the periphery of the trolley wheel, the shoe being counter-weighted to preserve good contact.

773,007. TELEPHONE SYSTEM; Richard M. Eaton, Philadelphia, Pa. App. filed Dec. 31, 1901.

773,024. SIGNALING; John Millar, Kearney, N. J. App. filed Oct. 22, 1902. Comprises a semaphore counterweighted so as to have a bias to the "danger" position, and a motor for moving the semaphore to "caution" and then to "clear," and a restoring device operated by the motor to restore the semaphore to "danger" and means for operating said restoring device in case the semaphore fails to return to "danger" by gravity.

773,025. SIGNALING; John Millar, Kearney, N. J. App. filed Oct. 22, 1902. See preceding patent.

773,039. SIGNALING SYSTEM; Howell W. Souder, Tamaqua, Pa. App. filed Oct. 22, 1902. Electric signaling system adapted for use on single track trolley roads which are divided into a plurality of signal blocks. Different colored lamps in the circuit indicate condition of block.

773,040. BLOCK SIGNAL SYSTEM; Howell W. Souder, Tamaqua, Pa. App. filed Dec. 7, 1903. Also for single track trolley roads. Both semaphores and lamps are used, the latter being cautionary signals.

773,048. TROLLEY WHEEL; Ray E. Briggs, Chicago, Ill. App. filed June 15, 1904. Three or more trolley wheels are mounted in a horizontal frame made in sections pivotally connected together, the middle section of the frame being pivoted to the trolley pole.

773,065. ELECTRICAL RAILWAY SIGNAL; James L. Dickey, Atlanta, Ga. App. filed Aug. 29, 1902. Details.

773,069. APPARATUS FOR UTILIZING ELECTRICAL OSCILLATIONS FOR SIGNALING PURPOSES; Clarence E. Freeman, Chicago, Ill. App. filed Jan. 14, 1901. Comprises a transmitting station and a receiving station and means for generating successive wave-trains with all the wave-trains having substantially the same maximum amplitude, and receiving apparatus arranged at the receiving station.

773,080. ELECTRICAL SIGNAL FOR RAILWAYS; Wilbur C. Lamphier, Worcester, Mass. App. filed June 17, 1903. Designed for trolley roads. Lights of different colors located at ends of blocks being the signaling means.

773,119. CIRCUIT BREAKER; Adolph F. Christmas, Pittsburg, Pa. App. filed June 22, 1903. Details of a breaker adapted for the control of the circuit for operating electrical reciprocating tools.

773,120. ELECTRIC MOTOR SYSTEM; Adolph F. Christmas, Pittsburg, Pa. App. filed Dec. 2, 1903. Relates to reciprocating tools. A rotary circuit breaker comprising a chamber partially filled with mercury and arms which alternately co-operate therewith, control the circuit of a two-coil reciprocating motor.

773,121. ROTARY MERCURY CIRCUIT BREAKER; Adolph F. Christmas, Pittsburg, Pa. App. filed Dec. 2, 1903. Consists, generally stated, in breaking the circuit between suitable metallic terminals, one of which is a body of mercury inclosed in a practically-sealed chamber, so that the arcs which are necessarily formed will expend themselves in volatilizing the mercury, but the latter being contained in a closed chamber will immediately condense and again join the main body of mercury.

773,122. ELECTRIC HAMMER; Adolph F. Christmas, Pittsburg, Pa. App. filed Dec. 2, 1903. Details of a two-coil reciprocating tool.

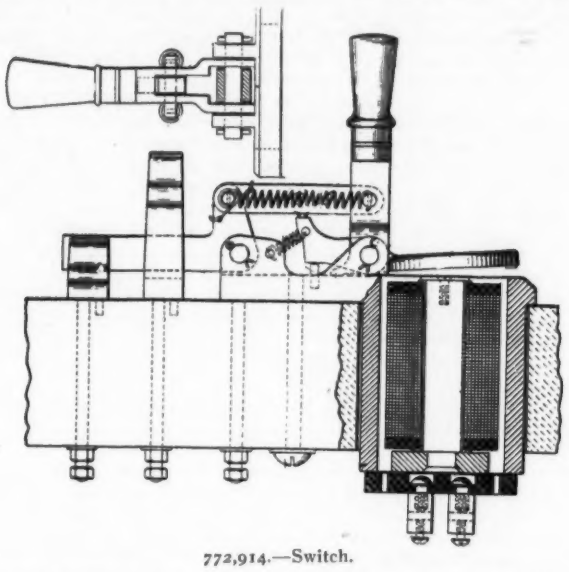
773,123. ROTARY MERCURY CIRCUIT BREAKER; Adolph F. Christmas, Pittsburg, Pa. App. filed Dec. 4, 1903. See preceding patents.

773,124. ELECTRIC HAMMER; Adolph F. Christmas, Pittsburg, Pa. App. filed Dec. 4, 1903. An electrical reciprocating tool in which a single coil is employed.

773,129. DYNAMO; Isidor Duetsch, Montreal, Canada. App. filed May 14, 1903. Relates to dynamos subject to variations in speed and direction and provides automatic means for regulating the generation of the current.

773,166. ELECTRIC SIGNAL SYSTEM; Howell W. Souder, Tamaqua, and John Early, Lansford, Pa. App. filed Dec. 7, 1903. Relates to block signals for single track trolley systems. Improvements on prior patents.

773,171. METHOD OF RECEIVING ELECTRICAL IMPULSES; Daniel W. Troy, New York, N. Y. App. filed April 8, 1904. Relates primarily to apparatus and methods of wireless or space telegraphy and consists in



772,914.—Switch.

displacing electrical discharges in vacuum by means of the energy of received impulses.

773,182. AUTOMATIC ELECTRIC SWITCH; James I. Ayer, Cambridge, Mass. App. filed June 27, 1904. Solenoid magnets operate an electric switch for opening and closing the circuit, the solenoids being energized by auxiliary circuits controlled by a thermostat governed by the caloric condition of an electric furnace in the main circuit.

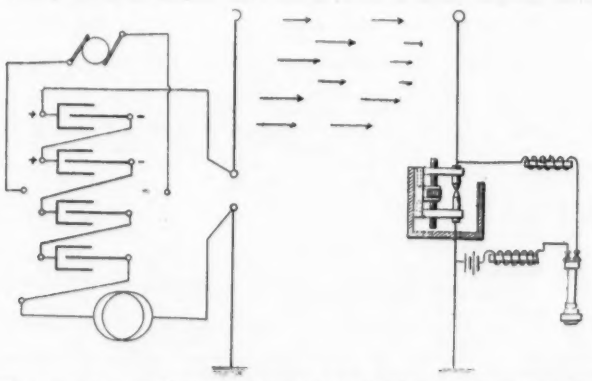
773,187. TELEPHONE SIGNALING DEVICE; Donald M. Bliss, Brookline, Mass. App. filed Sept. 19, 1902.

773,195. RELAY; Thomas A. Casey, Jersey City, N. J. App. filed March 16, 1904. Provides for adjustment of armature of telegraphic relays.

773,198. TELEGRAPH SYSTEM; Albert C. Crehore, Yonkers, N. Y. App. filed Aug. 12, 1903. Relates to that system of telegraphy in which messages are transmitted by means of a keyboard arranged like the keyboard of an ordinary typewriter—each button operating a circuit closer, and to receive the messages on a similar typewriter the keys of which are operated by electro-magnets. The present invention discloses the arrangement of circuits only.

773,201. FUSE; Louis W. Downes, Providence, R. I. App. filed April 29, 1904. Provides means for fastening the caps in place against the gaseous pressures generated upon the blowing of the fuse, and supporting the terminal blades.

773,213. ELECTRICAL CONTROLLER ATTACHMENT; Albert H. Mathewson, Thompsonville, Conn. App. filed April 7, 1904. An attachment for



773,069.—Apparatus for Utilizing Electrical Oscillations for Signaling Purposes.

trolley car controllers which will require the motorman to dwell at each notch when throwing on power, but which will permit the handle to move freely when turning power off.

773,246. MAGNETIC SEPARATOR; John W. Carnochan, Silver Creek, N. Y. App. filed Nov. 27, 1903. A detachable separator adapted to be applied to the hopper of ordinary coffee mills to remove magnetic particles from the coffee preparatory to grinding.

773,249. CLAMP FOR BATTERY ELECTRODES; Eben G. Dodge, Orange, N. J. App. filed June 27, 1904.

773,263. ELECTRIC TRAIN SIGNAL; Ernest M. Quittmeyer, Bridgeport, Conn. App. filed Dec. 23, 1903. A system in which the signals are located in the cabs of locomotives. A number of blocks are controlled from a single tower.

773,280. TROLLEY HARP; Thomas Egan, Muscatine, Ia. App. filed April 14, 1904. Two springs bowed toward each other are attached to the harp for the purpose of retaining the trolley wheel on the wire.

773,286. ANTISEPTIC ATTACHMENT FOR TELEPHONE MOUTHPIECES; Gerhardt E. Grimm; Collingswood, N. J. App. filed July 25, 1904.

773,314. TROLLEY CATCHER; Charles F. Davy, Mohawk, N. Y. App. filed June 20, 1904. Mechanical details.

773,323. CIRCUIT OPERATING DEVICE; Charles F. Hopewell, Cambridge, Mass. App. filed Aug. 17, 1904. A differential circuit-operating device especially adapted for trolley signals which may be operated by a passing car to set and extinguish the signals, the signals being set when the car passes along in one direction and extinguished when the car passes along in the opposite direction.

773,331. ELECTRIC BATTERY; Charles F. Mackey, Philadelphia, Pa. App. filed Dec. 11, 1903.

773,334. TROLLEY SIGNAL; Charles H. Morse, Cambridge, Mass. App. filed Sept. 21, 1903. In accordance with this invention the car when passing a given point or signal station sets the signal at said station to thus leave a signal set behind it and when passing the next signal station restores said previously set signal and also sets the signal at said station so that a signal is always set in rear of the moving car.

773,340. TELEGRAPHIC RECEIVING SYSTEM BY MEANS OF HERTZIAN WAVES; Octave Rochefort, Paris, France. App. filed Aug. 25, 1903. Relates to a telegraphic receiving system of Hertzian waves, and involves a method of reinforcing the action of the wave by a novel coherer termed the "coherer-condenser."

773,369. ELECTRICAL BLOCK SIGNAL; Howard Brooks, Wheaton, Ill. App. filed Dec. 21, 1903. A closed circuit system, employing electromagnets having a plurality of windings which are independently charged for the operation of the semaphore.

773,372. ELECTRIC CIRCUIT; George A. Campbell, Newton, Mass. App. filed March 5, 1900. Comprises a step-up transformer and an electric conductor provided with self-induction coils of low resistance and high inductance applied in series at short intervals.

773,374. INSTRUMENT FOR THE TEACHING AND PRACTICE OF TELEGRAPHY; Charles E. Chinnock, Brooklyn, N. Y. App. filed Jan. 20, 1902. A number of discs having peripheral projections corresponding to signs of the Morse alphabet and arranged to produce a message, are mounted on a common center and rotated; a circuit breaker coacting with each disc successively throughout the series.

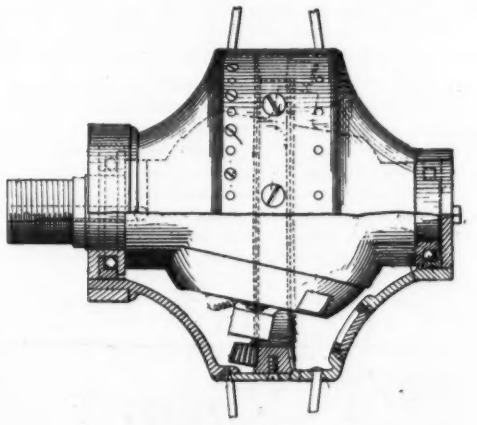
773,398. APPARATUS FOR REGULATING VOLTAGE; Maurice Leblanc, Paris, France. App. filed Jan. 5, 1903. (See Current News and Notes.)

773,399. REGULATING APPARATUS FOR CONSTANT-CURRENT GENERATORS; Maurice Leblanc, Paris, France. App. filed Feb. 26, 1903. (See Current News and Notes.)

773,400. METHOD OF REGULATING CONSTANT-CURRENT DYNAMOS; Maurice Leblanc, Paris, France. App. filed Feb. 26, 1903. (See Current News and Notes.)

773,407. APPARATUS FOR ELECTRICAL TREATMENT OF AIR; John Elvin Mitchell and Dennis Parks, St. Louis, Mo. App. filed July 9, 1904.

773,410. AUTOMATIC GAS IGNITER; Harry B. McNulty, Washington, D. C. App. filed Oct. 22, 1903. Details aiming to electrically open a



12,281.—Electric Motor.

valve and ignite the gas without vibrating or jarring the parts of the structure.

773,411. ELECTRIC IGNITER; Harry B. McNulty, Washington, D. C. App. filed Oct. 22, 1903. Details contemplating the production of a structure wherein the removal and replacing of the platform resistance is facilitated.

773,415. SIGNALING SYSTEM FOR RAILWAYS; Charles Goodman Otwell and Ira H. Melvin, Laurel, Del. App. filed Feb. 11, 1904. Details of a system in which a signal is given (bell rung) in the cab of locomotive.

773,416. ELECTRIC DESPATCH BOX FOR OVERHEAD LINES; Roberto T. Piscicelli, Naples, Italy. App. filed July 3, 1903. A wedge-shaped casing contains a motor in front and a box for correspondence arranged behind the latter acting as a sort of guiding rudder.

773,438. ELECTRIC RAILWAY; George H. Thomas and Martin J. Stone, Scranton, Pa. App. filed Oct. 14, 1903. The rail is provided with side coverings and two converging, hinged top-covering flaps made in sections and normally closed.

773,459. TROLLEY; Martin L. Beistle, Ingram, Pa. App. filed Aug. 15, 1904. The trolley wheel is mounted in a frame which is pivoted to a harp, swiveled to the pole.

773,464. ELECTRIC SWITCH; Albert G. Bodine, Baldwin Township, Pa. App. filed Feb. 2, 1904. A trolley switch operated by a passing car.

773,467. ELECTRIC SWITCH; Walter L. Bradshaw, Cambridge, Mass. App. filed Feb. 24, 1904. Relates to switches for controlling a lighting circuit for refrigerators or the like, the lights being turned off or on by the turning of the handle of the door.

773,472. ELECTRIC CIRCUIT; George A. Campbell, Newton, Mass. App. filed July 7, 1904. See patent No. 773,372.

773,506. MULTIPLE SWITCHBOARD FOR TELEPHONE EXCHANGES; Milo G. Kellogg, Chicago, Ill. App. filed Feb. 28, 1891.

773,508. PROCESS OF REGULATING VOLTAGE; Maurice Leblanc, Paris, France. App. filed Feb. 5, 1904. (See Current News and Notes.)

773,523. LUBRICATION CONTROL FOR FLUID PRESSURE APPARATUS; Walter J. Richards, Milwaukee, Wis. App. filed Aug. 8, 1904. A magnetically operated oil cup feeds oil to the pump only during the operation of the pump; the electric circuits being controlled by a switch sensitive to the fluid pressure of the apparatus.

12,281. ELECTRIC MOTOR; Albert B. Holsin, Chicago, Ill. App. filed May 31, 1904. A motor construction adapted to the hub of a wheel and in which the hub (which is also the motor housing) is driven directly by the motor.

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The making of standard types of controllers is not by any means our whole work.

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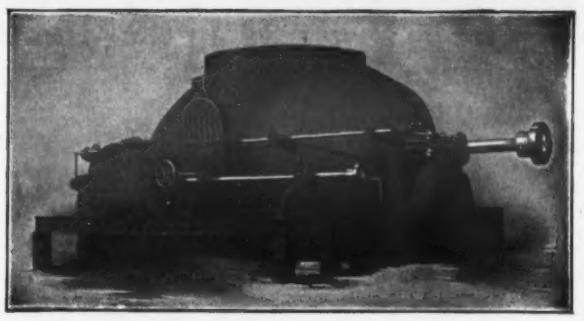

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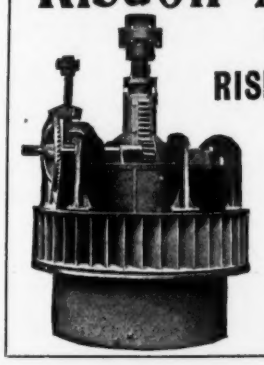

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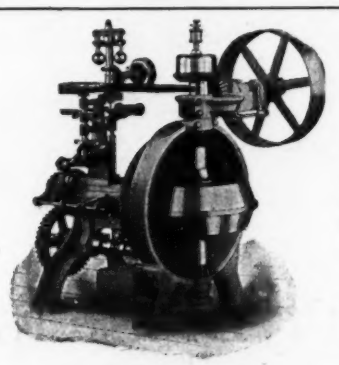

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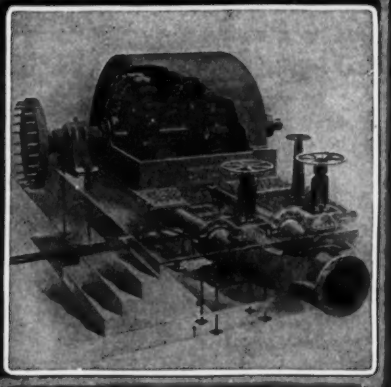

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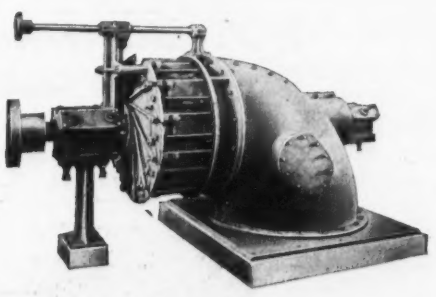

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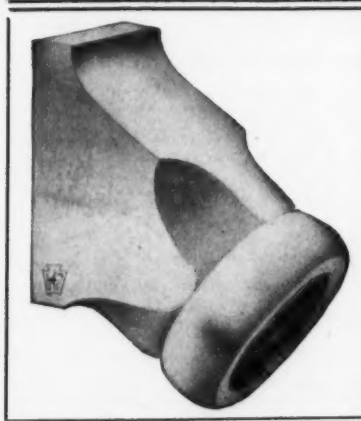

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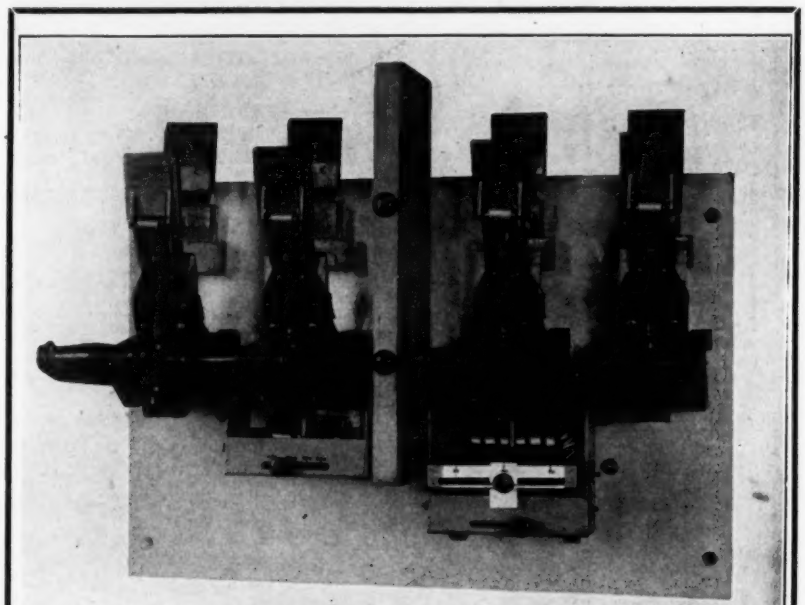

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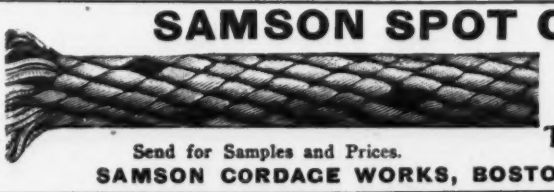

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